FINAL
ENVIRONMENTAL STATEMENT
FOR THE
PROTOTYPE OIL SHALE LEASING PROGRAM

Volume III of VI

Specific Impacts of Prototype Oil Shale Development

U.S. DEPARTMENT OF THE INTERIOR
1973

F I N A L

ENVIRONMENTAL STATEMENT

FOR THE

PROTOTYPE OIL SHALE LEASING PROGRAM

Volume III of VI

Description of Selected Tracts

and

Potential Environmental Impacts

Prepared in Compliance With

Section 102 (2) (c) of the National Environmental

Policy Act of 1969

Prepared by

UNITED STATED DEPARTMENT OF THE INTERIOR

1973

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SUMMARY

Final Environmental Statement
Department of the Interior, Office of the Secretary

1. Administrative type of action:

2. Brief description of action:

   This action would make available for private development up to six leases of public oil shale lands of not more than 5,120 acres each. Two tracts are located in each of the States of Colorado, Utah, and Wyoming.

   Such leases would be sold by competitive bonus bidding and would require the payment to the United States of royalty on production. Additional oil shale leasing would not be considered until development under the proposed program had been satisfactorily evaluated and any additional requirements under the National Environmental Policy Act of 1969 had been fulfilled.

3. Summary of environmental impact and adverse environmental effects:

   Oil shale development would produce both direct and indirect changes in the environment of the oil shale region in each of the three States where commercial quantities of oil shale resources exist. Many of the environmental changes would be of local significance, and others would be of an expanding nature and have cumulative impact. These major regional changes will conflict with uses of the other physical resources of the areas involved. Impacts would include those on the land itself, on water resources and air quality, on fish and wildlife habitat, on grazing and agricultural activities, on recreation and aesthetic values, and on the existing social and economic patterns as well as others. The environmental impacts from both prototype development at a level of 250,000 barrels per day of shale oil and an industry producing a possible 1 million barrels per day by 1985 are assessed for their anticipated direct, indirect and cumulative effects.

4. Alternatives considered:

   A. Government development of public oil shale lands.
   B. Change in number of tracts to be leased.
   C. Delay in development of public oil shale lands.
   D. No development of public oil shale lands.
   E. Unlimited leasing of public oil shale lands.
   F. Obtaining energy from other sources.

5. Comments have been requested from the following:

   Federal agencies, State agencies, and private organizations listed in Volume IV, Section F.

6. Date made available to the Council on Environmental Quality and the Public:

   Draft Statement: September 7, 1972

   Final Statement: August, 1973

INTRODUCTORY NOTE

THIS FINAL ENVIRONMENTAL STATEMENT HAS BEEN PREPARED PURSUANT TO SECTION 102 (2) (C) OF THE NATIONAL ENVIRONMENTAL POLICY ACT OF 1969 (42 U.S.C. SECS. 4321-4347). ITS GENERAL PURPOSE IS A STUDY OF THE ENVIRONMENTAL IMPACTS OF OIL SHALE DEVELOPMENT.

THE SECRETARY OF THE INTERIOR ANNOUNCED PLANS ON JUNE 29, 1971, FOR THIS PROPOSED PROGRAM AND RELEASED A PRELIMINARY ENVIRONMENTAL STATEMENT, A PROGRAM STATEMENT, AND REPORTS PREPARED BY THE STATES OF COLORADO, UTAH, AND WYOMING ON THE ENVIRONMENTAL COSTS AND PROBLEMS OF OIL SHALE DEVELOPMENT.

THE PROPOSED PROGRAM IS IN CONCERT WITH THE PRESIDENT'S ENERGY MESSAGE OF JUNE 4, 1971, IN WHICH HE REQUESTED THE SECRETARY OF THE INTERIOR TO INITIATE "A LEASING PROGRAM TO DEVELOP OUR VAST OIL SHALE RESOURCES, PROVIDED THAT ENVIRONMENTAL QUESTIONS CAN BE SATISFACTORILY RESOLVED."

AS PART OF THE PROGRAM, THE DEPARTMENT AUTHORIZED INFORMATIONAL CORE DRILLING AT VARIOUS SITES IN COLORADO, WYOMING, AND UTAH AND 16 CORE HOLES WERE COMPLETED. THE DEPARTMENT REQUESTED NOMINATIONS OF PROPOSED LEASING TRACTS ON NOVEMBER 2, 1971, AND A TOTAL OF 20 INDIVIDUAL TRACTS OF OIL SHALE LAND WERE NOMINATED. WITH THE CONCURRENCE OF THE CONCERNED STATES, THE DEPARTMENT OF THE INTERIOR ANNOUNCED ON APRIL 25, 1972, THE SELECTION OF SIX OF THESE TRACTS, TWO EACH IN COLORADO, UTAH, AND WYOMING.

THE PROGRAM IS ESSENTIALLY UNCHANGED FROM THAT ANNOUNCED ON JUNE 29, 1971, BUT THE PRELIMINARY STATEMENT ISSUED AT THAT TIME

WAS EXPANDED TO CONSIDER THE IMPACT OF MATURE OIL SHALE DEVELOPMENT, THE IMPACT OF DEVELOPMENT OF THE SIX SPECIFIC TRACTS, AND A COMPREHENSIVE ANALYSIS OF OTHER ENERGY ALTERNATIVES.

THE DRAFT OF THIS FINAL ENVIRONMENTAL STATEMENT WAS RELEASED TO THE PUBLIC ON SEPTEMBER 7, 1972. A PUBLIC REVIEW PERIOD WAS HELD THAT ENDED ON NOVEMBER 7, 1972. THIS REVIEW PROVIDED IMPORTANT INFORMATION UPON WHICH TO EXPAND AND CORRECT, WHERE APPROPRIATE, THE DRAFT MATERIAL.

VOLUME I OF THIS FINAL SET OF SIX VOLUMES PROVIDES AN ASSESSMENT OF THE CURRENT STATE OF OIL SHALE TECHNOLOGY AND DESCRIBES THE REGIONAL ENVIRONMENTAL IMPACT OF OIL SHALE DEVELOPMENT AT A RATE OF ONE MILLION BARRELS PER DAY BY 1985. VOLUME II EXTENDS THIS STUDY WITH AN EXAMINATION OF ALTERNATIVES TO THE ONE MILLION BARREL PER DAY LEVEL OF SHALE OIL PRODUCTION. VOLUMES I AND II THUS CONSIDER THE REGIONAL AND CUMULATIVE ASPECTS OF A MATURE OIL SHALE INDUSTRY.

VOLUME III EXAMINES THE SPECIFIC ACTION UNDER CONSIDERATION, WHICH IS THE ISSUANCE OF NOT MORE THAN TWO PROTOTYPE OIL SHALE LEASES IN EACH OF THE THREE STATES OF COLORADO, UTAH, AND WYOMING. ITS FOCUS IS ON THE SPECIFIC ENVIRONMENTAL IMPACTS OF PROTOTYPE DEVELOPMENT ON PUBLIC LANDS WHICH, WHEN COMBINED, COULD SUPPORT A PRODUCTION POTENTIAL OF ABOUT 250,000 BARRELS PER DAY.

VOLUME IV DESCRIBES THE CONSULTATION AND COORDINATION WITH OTHERS IN THE PREPARATION OF THE FINAL STATEMENT, INCLUDING COMMENTS RECEIVED AND THE DEPARTMENT'S RESPONSES. LETTERS RECEIVED DURING THE REVIEW PROCESS ARE REPRODUCED IN VOLUME V, AND ORAL TESTIMONY IS CONTAINED IN VOLUME VI.

THIS DOCUMENT IS BASED ON MANY SOURCES OF INFORMATION, INCLUDING RESEARCH DATA AND PILOT PROGRAMS DEVELOPED BY BOTH THE GOVERNMENT AND PRIVATE INDUSTRY OVER THE PAST 30 YEARS. MANY FACTORS, SUCH AS CHANGING TECHNOLOGY, EVENTUAL OIL PRODUCTION LEVELS, AND ATTENDANT REGIONAL POPULATION INCREASES ARE NOT PRECISELY PREDICTABLE. THE IMPACT ANALYSIS INCLUDED HEREIN IS CONSIDERED TO CONSTITUTE A REASONABLE TREATMENT OF THE POTENTIAL REGIONAL AND SPECIFIC ENVIRONMENTAL EFFECTS THAT WOULD BE ASSOCIATED WITH OIL SHALE DEVELOPMENT.

IT SHOULD BE NOTED THAT SUBSTANTIAL AMOUNTS OF PUBLIC LANDS IN ADDITION TO THE PROTOTYPE TRACTS WOULD BE REQUIRED FOR AN INDUSTRIAL DEVELOPMENT TO THE ONE MILLION BARREL PER DAY LEVEL CONSIDERED IN VOLUMES I AND II. IF EXPANSION OF THE FEDERAL OIL SHALE LEASING PROGRAM IS CONSIDERED AT SOME FUTURE TIME, THE SECRETARY OF THE INTERIOR WILL CAREFULLY EXAMINE THE ENVIRONMENTAL IMPACT WHICH HAS RESULTED FROM THE PROTOTYPE PROGRAM AND THE PROBABLE IMPACT OF AN EXPANDED PROGRAM. BEFORE ANY FUTURE LEASES ON PUBLIC LANDS ARE ISSUED, AN ENVIRONMENTAL STATEMENT, AS REQUIRED BY THE NATIONAL ENVIRONMENTAL POLICY ACT, WILL BE PREPARED.

AVAILABILITY OF FINAL ENVIRONMENTAL STATEMENT

The six-volume set may be purchased as a complete set or as individual volumes from the Superintendent of Documents, U. S. Government Printing Office, Washington, D. C. 20402; the Map Information Office, Geological Survey, U.S. Department of the Interior, Washington, D. C. 20240; and the Bureau of Land Management State Offices at the following addresses: Colorado State Bank Building, 1600 Broadway, Denver, Colorado 80202; Federal Building, 124 South State, Salt Lake City, Utah 84111; and Joseph C. O'Mahoney Federal Center, 2120 Capital Avenue, Cheyenne, Wyoming 82001.

Inspection copies are available in the Library and the Office of the Oil Shale Coordinator, U.S. Department of the Interior, Washington, D. C., and at depository libraries located throughout the Nation. The Superintendent of Documents may be consulted for information regarding the location of such libraries. Inspection copies are also available in Denver, Colorado, in the Office of the Deputy Oil Shale Coordinator, Room 237E, Building 56, Denver Federal Center, Denver, Colorado 80225, in all the Bureau of Land Management State Offices listed above, and in the following Bureau of Land Management district offices: Colorado: Canon City, Craig, Glenwood Springs, Grand Junction, Montrose; Utah: Vernal, Price, Monticello, Kanab, Richfield; Wyoming: Rock Springs, Rawlins, Casper, Lander, Pinedale, Worland.

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I. DESCRIPTION OF THE PROPOSED ACTION

A. Introduction

Volume I of the Final Environmental Statement has detailed the nature of the resource and the potential impact from a mature oil shale industry that may develop on both private and public lands (1).[1/] This volume considers the impacts associated with the development of the six specific tracts which would be offered under the Department's proposed prototype oil shale leasing program described in this volume.

Oil shale is a leasable mineral, subject to the provisions of the Mineral Leasing Act of 1920, as amended (2). Under the authority and guidance provided by this act and other public land laws, the responsibility for managing and leasing public oil shale lands is vested in the Secretary of the Interior.[2/] This prototype program has been formulated to make available for private development under carefully controlled conditions, a limited number of leases (six) of not more than 5,120 acres each. Specifically, the objectives of the program are to:

(1) Provide a new source of energy that will increase the range of energy options available to the Nation by stimulating the timely development of commercial oil shale technology by private industry;

1/ Underlined numbers in parenthesis refer to items in the list of references at the end of each chapter.

2/ The withdrawal of oil shale lands under Executive Order 5327 would be modified to allow the issuance of oil shale leases for the selected tracts. No oil shale leases have been issued since 1925.

(2) Insure the environmental integrity of the affected areas, and concurrently, define, describe, and develop a full range of environmental safeguards and restoration techniques that can be reasonably incorporated into the planning for a possible mature oil shale industry in the future;

(3) Permit an equitable return to all parties in the development of this public resource; and

(4) Develop management expertise in the leasing and supervision of oil shale resource development in order to provide the basis for future administrative procedures.

This program will make available to private enterprise, for development under lease, a limited amount of public oil shale resources. Such leases would be sold by competitive bonus bidding subject to rental and royalty obligations to the United States. Additional oil shale leasing will not be considered until development under the prototype program has been satisfactorily evaluated in terms of the above-stated objectives.

The goal and scope of the program are as follows:

GOAL

The goal of the Department of the Interior's prototype leasing program is to provide a new source of energy for the Nation by stimulating the timely development of commercial oil shale technology by private enterprise, and to do so in a manner that will assure the minimum possible impact on the present environment while providing for the future restoration of the immediate and surrounding area.

SCOPE

The primary oil shale resources of Colorado, Utah, and Wyoming cover an 11-million-acre area. The leases to be offered

under this program can, by law, include no more than 5,120 acres for each lease or a total of 30,720 acres for the combined six leases.

This program would, therefore, affect only a small portion of the Nation's oil shale resource. The results of prototype development will provide the background information needed to formulate comprehensive resource utilization programs and regional land use plans. Additional lease of public oil shale lands will not be considered until the prototype development permitted and resulting impacts under this prototype program have been fully evaluated.

B. Environmental Impact Studies

The assessment of the environmental consequences of this prototype oil shale leasing program has been an evolving process over a 3-year period beginning in 1969, continuously becoming more specific about the nature and magnitude of potential impacts. Following a review of available data in early 1970, detailed studies were initiated in May and June of 1970, when the Department of the Interior requested the Governors of Colorado, Utah, and Wyoming to form panels to study the impact upon the environment if oil shale leases were to be developed in their States and to determine the costs of appropriate environmental controls. Each of the Governors commissioned a study in accordance with the following guidelines suggested by the Department of the Interior in 1970:

> Specifically, the environmental requirements of returning the residues from mining and refining to the earth for further use, and those costs involved will be developed between the Department and the States.
>
> It is suggested that proposed methods of development for typical areas in each State be outlined and selected methods for mining and processing be studied. Each outline should include the current applicable regulations for each phase of the operations, or the proposed regulations to be adopted where the current standards have not

been developed, in order that the resulting economic cost may be evaluated.

Proposed methods of development should include:

(1) Underground mining, with underground disposal,
(2) Underground mining with surface disposal,
(3) Surface mining with backfill; and
(4) In situ operations.

Particular care shall be taken to assure that the following provisions are included:

(1) Air quality standards are maintained,
(2) Surface and ground water quality is maintained,
(3) Restoration of the lands is commensurate with future land use plans,
(4) Wildlife habitat is protected and restored for future use; and
(5) Scenic and aesthetic values are to be maintained.

The resulting studies should provide that future land use requirements will be in accordance with State and local plans for development.

Specific requirements as to soil compaction, drainage, revegetation, and community development plans should be in included in each summary in order that a complete economic evaluation of the total environmental costs may be made by the Department and by prospective lessees.

The basis for preparing the Preliminary Draft Environmental Impact Statement, which was issued in June 1971, was provided by the States of Colorado, Utah, and Wyoming and by Departmental and Interagency studies. The initial detailed 7-month study of lease sites, typical of those that were nominated for development under the program, involved more than 150 professionals with diverse backgrounds, including representatives from various Federal and State agencies, research foundations, universities, independent conservation groups, and industrial firms. The State documents

are available[1/] and contain additional information concerning the expected environmental impact and controls that could be applied if oil-shale operations were initiated.

At that time, however, it was apparent that not enough specific information was available on which to base an evaluation of the impact of development of a particular tract. Informational core drilling on public oil shale lands was authorized in June 1971. This phase of the program development has proceeded under strict environmental standards, and no significant impact resulted from these coring activities.

Informational core drilling operations and lease nominations identified the areas of greatest commercial interest and aided in focusing efforts aimed at assessing environmental impacts. From the 20 individual tracts nominated, two in each State were selected by the Department in consultation with the three State governments involved (See Chapter IX).

The type of mining-waste disposal system(s) most likely to be used if the selected sites were developed was then evaluated in relation to the actual characteristics of the areas (Chapter III of this Volume).

These environmental studies and additional baseline data to be obtained for each prototype tract will establish the known prevailing conditions against which the estimated environmental impact

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1/ Individual reports (without appendices) prepared by the States of Colorado, Utah, and Wyoming may be purchased through the U. S. Geological Survey, Map Information Office, Room 1038, General Services Building, Washington, D.C. 20240, at $2.00 a copy.

can be measured. Highlights of the prototype leasing program are set forth below. The applicable mining regulations and proposed lease and environmental stipulations are contained in Chapter V of this Volume.

C. Program Implementation

Should a decision be reached to implement the proposed program, operations would proceed under the terms of a lease specifically designed to achieve the stated program goal given above on page I-2. To achieve this goal, an interlocking set of bonus, royalty, bonding, and performance provisions have been developed and are in the proposed lease given in Chapter V of this volume, an overview of which is given below.

1. Lease Offerings

Sealed competitive bonus bids accompanied by acceptable preliminary development plans will determine who will be granted a lease. Sealed bidding is an established market tested method for obtaining an equitable return for the resource when potential competition for the leases cannot be readily predetermined. This method is currently being used by the Department of the Interior in competitive leasing of the mineral resources on the Outer Continental Shelf. In the early stages of an oil shale industry, the number of bidders may be limited by (1) lack of an economically proved technology and (2) large investment commitments that may exceed $200 million or more for each lease to be developed.

To provide for efficient development of the oil shale resources the lease will include the right to produce other minerals in addition to shale oil if any prove to be present in significant and economic quantities in the oil shale deposits on the lease tracts.

Immediate payment of the full bonus bids to acquire these first leases could create an undesirable economic burden on development because of other large investment requirements in the early years of a lease operation and the lack of an established technology with accurately predictably capital and operating costs. To reduce this economic burden, the bonus will be payable in five equal annual installations.

2. Term, Rental, and Royalty

The primary lease term is for 20 years and as long thereafter as there is production in commercial quantities. Readjustment of royalty and operating terms may be made at the end of each 20-year period. Annual rental of 50 cents per acre per year for the use of the land will be charged as required by the Mineral Leasing Act of 1920, as amended, and is creditable against royalties.

Royalty is money due and payable to the lessor for the removal of the resource from the leased lands by the lessee.[1/] The royalty rate for shale oil under this prototype program would be 12 cents for each ton of oil shale mined for processing that contains 30 gallons for shale oil per ton of material. Under the proposed lease

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1/ The proposed royalty rate is comparable to other minerals mined under the Mineral Leasing Act of 1920.

(Chapter V, Section A), this rate would be adjusted, depending on the actual oil content of the mined material and the market value of locally produced liquid hydrocarbons. Additional royalty would be collected on minerals other than shale oil produced under the lease.

To encourage development and avoid long delays in shale oil production from the leases, payment of minimum royalties will be required. Beginning in the sixth lease year the royalty payments will be based on minimum production rates derived from the estimated recoverable oil shale reserves contained in each tract. The required minimum royalty payment will increase each year through the 15th lease year and then remain the same through the 20th year at which time the lease terms may be readjusted. For example, assuming a recoverable reserve of 2.1 billion tons of oil shale (1.5 billion barrels of shale oil) that averages 30 gallons of oil per ton, the calculated minimum production rate during the 6th year would be 3,500 tons per day of oil shale. Each year the calculated minimum production would increase a like amount to and including the 15th year (i.e., in the foregoing example, to 35,000 tons per day).

Early production incentives are also provided which will permit under certain circumstances the credit of a portion of development costs incurred during the early years of a lease against bonus and royalty payments due the government.

Each tract described in the chapter which follows has been evaluated for total recoverable oil shale reserves by various techniques. This information is provided in Table I-1 and provides the basis for computing the minimum royalties as provided in Sec. 7 of the lease.

TABLE I-1.-- Oil Shale Reserves, Prototype Tracts

Tract	Extraction Method	Estimated Recoverable Oil-Shale Reserves
Colorado C-a	Underground	1,857,000,000 tons in mineable beds containing 30 or more gallons per ton.
Colorado C-b	Underground	1,012,000,000 tons in mineable beds containing 30 or more gallons per ton.
Utah U-a	Underground	342,000,000 tons in mineable beds containing 30 or more gallons per ton.
Utah U-b	Underground	372,000,000 tons in mineable beds containing 30 or more gallons per ton.
Wyoming W-a	In Situ	354,000,000 tons in mineable beds containing 20 or more gallons per ton.
Wyoming W-b	In Situ	352,000,000 tons in mineable beds containing 20 or more gallons per ton.

3. Performance Requirements

Lease operations will proceed only under approved development plans and continued acceptable performance by the lessee. A preliminary plan for lease development by a prospective lessee must be incorporated in all lease offers submitted to the Department of the Interior. After lease issuance and before the submission of a development plan which will provide for operations other than exploratory operations on the leased tract, the lessee will be required

by lease stipulations to obtain at least 1 full year of additional baseline environmental data against which the actual environmental impact of the proposed development will be measured. Baseline air and water quality data, fish and wildlife populations and movement, and detailed descriptions of the existing vegetative cover are among the most important of ambient characteristics that will be established under this stipulation.

The collection of baseline data for an additional year and a monitoring program will be integral parts of the detailed development plan to be prepared before the third anniversary of each lease. These plans must provide for compliance with all of the established environmental criteria and receive Departmental approval prior to the start of operations. They must include detailed projected analyses of the amount and types of expected waste materials, the location and extent of the disposal areas, the types and amount of vegetation that will be used in land restoration, and adequate assurance to this Department that the lessee has designed his disposal-restoration systems to protect the long-run productivity of the affected areas. These plans will be subject to public hearings conducted by the Department on the environmental aspects of the proposed operations. Only after such hearings and consultation with State and local officials may the plans be approved, and then only after the Mining Supervisors are satisfied that all lease terms, stipulations, and provisions will be satisfied. The lessee will be expected to plan construction and other developmental

activities in full coordination with the land use, transportation, and other plans of the counties of other local public agencies. Annual progress reports will be required, and all physical facilities and records pertaining to the operations may be inspected by the Department as part of its continuous monitoring of the operation. Section 1(C) of the lease stipulations provides for an environmental monitoring program which will measure the impacts of development. The results will be assessed by the Department and annual reports will be released for public review.

4. Bonding

A bond would be required as security to ensure that the approved development-restoration plan would be conducted in a manner designed to avoid degradation of the environment and that all other related lease terms would be met. The bond would be for not less than $2,000 per acre of land to be involved in actual mining operations or spent shale disposal and not less than $500 per acre for all other portions of the leased land that would be affected during the first 3-year period of operation. The total bond shall, in no event, be less than $20,000. Bonds for subsequent periods would be in sufficient amounts to provide for reclamation and restoration of disturbed lands.

5. Extraordinary Environmental Costs

The proposed lease gives the Secretary of the Interior discretionary authority to allow the credit of extraordinary environmental costs against production royalties due the

Government. Before the lessee can seek this relief, he must show that compliance with the environmental protection requirements under plans approved under regulations now or hereafter in force or imposed by new legislation has engendered extraordinary costs in excess of those in the comtemplation of the parties. This provision has been devised specifically and only for inclusion in the six prototype leases. Its purpose is to provide a method to help assure satisfactory environmental results without jeopardizing the economic viability of an operation in the event that unexpectedly high environmental costs develop. There is no intent to include such provisions in any oil shale leases beyond this prototype program.

D. Future Development of Federal Oil Shale Resources

The Department of the Interior has carefully formulated the concepts and details of the prototype oil-shale leasing program over an extended period of time. The program is a "prototype" since it seeks to establish a new cooperative effort between the private and public sectors to ensure the compatability of industrial development with environmental quality. As a prototype, it is the mechanism through which environmental impacts can be controlled and monitored before any large scale development occurs and is designed so that any extraordinary and unforeseen impacts, which may develop, occur on a widely separated and limited scale.

Through this concept, impacts will be minimized and larger industry development can be forestalled until fully adequate and proven solutions to environmental problems are available.

An important part of the effort has been full public participation, and, as outlined by the Secretary of the Interior (3):

> . . .The Department is committed to full disclosure of its efforts as it proceeds step by step toward the proposed program. If we make mistakes along the way, we expect to be told about it and will do our utmost to correct environmentally hazardous aspects of the program which are identified before irretrievable damage is done.

The Secretary also stressed that:

> No Federal leasing of oil shale lands beyond the proposed program, if implemented, will be carried out until the environmental effects of the prototype program indicating feasibility of developing of mature industry are fully evaluated. At that time, another environmental impact statement would be published and publicly reviewed.

Volume I of this analysis was addressed to the impact of an industry that would produce 1 million barrels of shale oil per day by 1985. Pending actual development, it is not possible to refine that analysis or to extrapolate the data to a mature industry producing more than 1 million barrels per day. The basis for such an analysis, however, will be provided by prototype development and the annual environmental assessments to be conducted.

When sufficient data has been accumulated and if the environmental impact of the prototype development is judged to be acceptable, the Secretary of the Interior may initiate procedures

under the Mineral Leasing Act and the National Environmental Policy Act to consider further development of public oil shale lands.

E. References

1. Environmental Impact Statement for the Oil Shale Leasing Program, v. 1, Regional Impact of Oil Shale Development, U. S. Department of the Interior, December 1972.

2. 30 U.S.C. § 181-263.

3. News Release, Secretary Morton Announces Draft of Interior's Plans for Prototype Program of Oil Shale Development, June 29, 1971.

II. DESCRIPTION OF THE ENVIRONMENT OF THE SELECTED TRACTS

A. Description of Prototype Tracts

In response to a call for nominations of potential lease sites dated November 2, 1971, 15 companies submitted 23 tracts for consideration. These nominations were received by the end of the designated period (January 31, 1972). Two additional tracts were also nominated by the State of Wyoming, thus bringing the total number of nominated sites to 25. After elimination of duplicate sites, 20 individual nominated tracts remained.

The nominated tracts were reviewed by a selection committee of Federal and State experts (Chapter IX). A total of six tracts, two in each State, were recommended for the prototype program. Chapter IX also contains the basic information on the 14 tracts not selected. Following further review by the Department of the Interior and representatives of the Governor's Advisory Task Force in each of the three States, the final tract selections for the proposed program were announced on April 25, 1972.

The general geographic location of the six tracts is shown in Figure II-1. These six tracts have been designated as Colorado C-a and C-b, Utah U-a and U-b, and Wyoming W-a and W-b. The section below details the legal description of the six tracts, maps of the topography, and typical aerial views of them. Subsequent sections of this chapter contain detailed descriptions of the existing environment. For a regional overview of the environment, the reader is referred to Chapter II of Volume I.

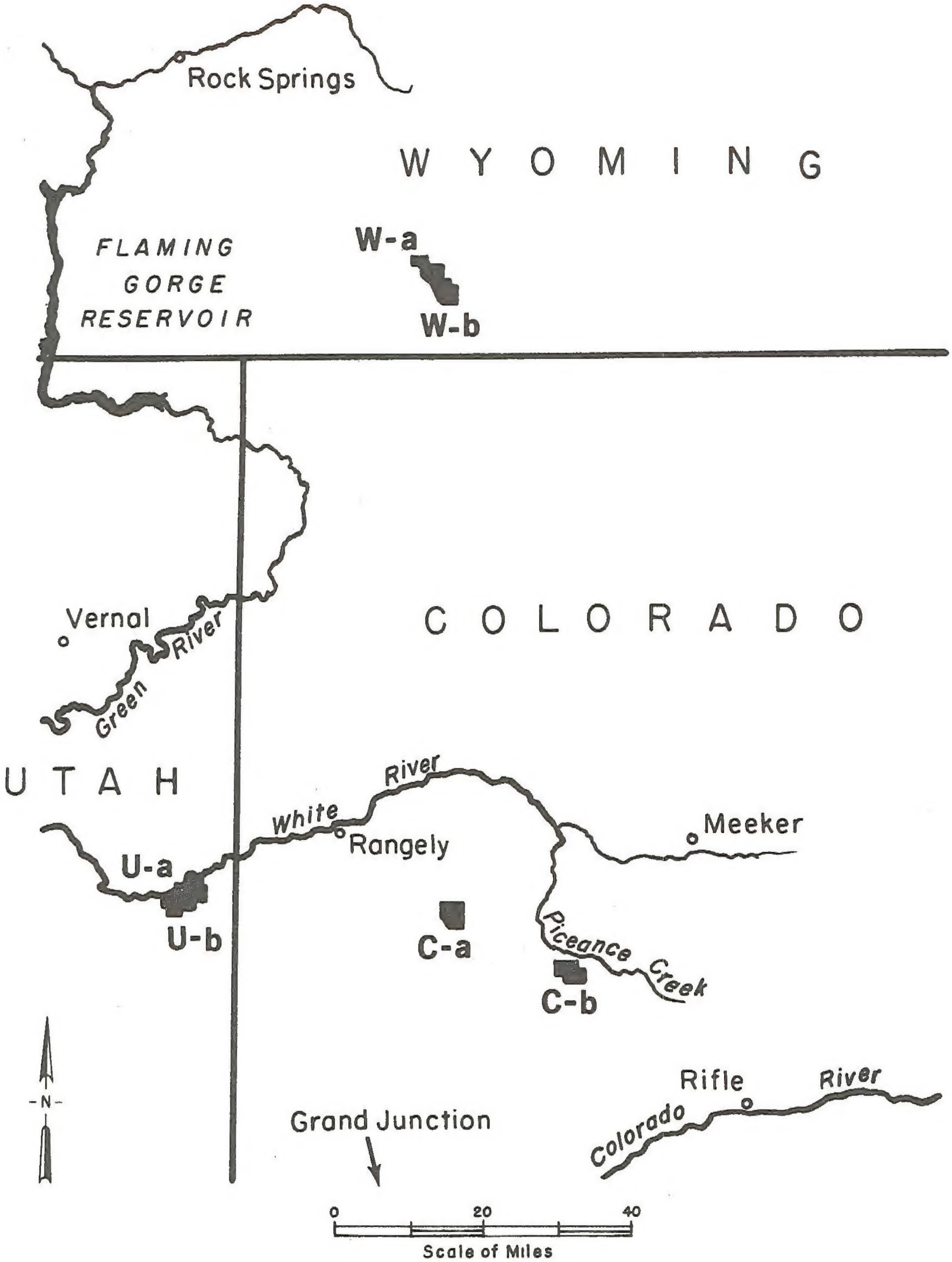


FIGURE II-1.--Map Showing General Geographic Location of the Six Oil Shale Tracts.

1. Selected Colorado Tracts

a. Description

Two sites, both in Rio Blanco County, Colorado, have been selected from the nominations and are designated as Tracts C-a and C-b. The legal descriptions of these tracts are given in Table II-1. Topographic plats are shown in Figures II-2 to II-5, principal features on and around the tracts are listed in Tables II-2 and II-3, and typical aerial views shown in Figures II-6 and II-7.

b. Land Status, Tract C-a

Surface and mineral rights on this tract are owned by the United States, except for the following portions of Township 1 South, Range 99 West (Figure II-2).

Section 33, NE¼SE¼, S½SE¼, SE¼SW¼: The surface and the unreserved minerals are owned by the Shields and Caldwell Hunting Camp, c/o Charles F. Shields, Box 188, Murietta, Calif. 92362. Oil and gas and oil shale or other rock valuable as a source of petroleum and nitrogen in the lands so patented are reserved to the United States (Patent 871543, Act of July 17, 1914).

Section 33, NE1/4, SE1/4NW1/4, NWL/4SE1/4, NE1/4SW1/4: The surface is owned by the Colorado Game, Fish and Parks Department. All minerals are reserved to the United States (Patent 1031800, Act of December 29, 1916.

Section 34 NW1/4NW1/4, S1/2N1/2, NW1/4SW1/4: The surface is owned by the Colorado Game, Fish and Parks Department. The minerals reserved to the United States are oil and gas and oil shale or other rock valuable as a source of petroleum and nitrogen in the lands so patented. (Patent 990142; Act of July 17, 1914). Fifty percent of the unreserved minerals are owned by the Colorado Game, Fish and Parks Department, and 50% are owned by Bell Petroleum Co.

c. Land Status, Tract C-b

There is no patented land on this site, but access is currently over a public road through private lands along Piceance Creek.

TABLE II-1.--Legal Description of the Two Colorado Oil Shale Tracts

	Acres
Tract C-a:	
T. 1 S., R. 99 W., 6th PM:	
Sec. 32: $E\frac{1}{2}$, $E\frac{1}{2}W\frac{1}{2}$	480.00
Sec. 33: All	650.40
Sec. 34: $W\frac{1}{2}$, $SE\frac{1}{4}$, $W\frac{1}{2}NE\frac{1}{4}$, $SE\frac{1}{4}NE\frac{1}{4}$	600.00
T. 2 S., R. 99 W., 6th PM:	
Sec. 3: All	639.98
Sec. 4: All	639.53
Sec. 5: $E\frac{1}{2}$, $E\frac{1}{2}W\frac{1}{2}$ (Incl. lots 1,2, &3)	479.79
Sec. 8: $E\frac{1}{2}$	320.00
Sec. 9: All	640.00
Sec. 10: All	640.00
Total	5,089.70
Tract C-b:	
T. 3 S., R. 96 W., 6th PM:	
Sec. 5: $W\frac{1}{2}SE\frac{1}{4}$, $SW\frac{1}{4}$	240.00
Sec. 6: Lot 6 (21.51), Lot 7 (21.43), $E\frac{1}{2}SW\frac{1}{4}$, $SE\frac{1}{4}$	282.94
Sec. 7: Lot 1 (21.39), Lot 2 (21.37), Lot 3 (21.35), Lot 4 (21.33), $E\frac{1}{2}W\frac{1}{2}$, $E\frac{1}{2}$	565.44
Sec. 8: $W\frac{1}{2}NE\frac{1}{4}$, $NW\frac{1}{4}$, $S\frac{1}{2}$	560.00
Sec. 9: $SW\frac{1}{4}$	160.00
Sec. 16: $NW\frac{1}{4}$, $W\frac{1}{2}SW\frac{1}{4}$	240.00
Sec. 17: All	640.00
Sec. 18: Lot 1 (21.34), Lot 2 (21.36), Lot 3 (21.40), Lot 4 (21.42), $E\frac{1}{2}W\frac{1}{2}$, $E\frac{1}{2}$	565.52
T. 3 S., R. 97 W., 6th PM:	
Sec. 1: $S\frac{1}{2}$	320.00
Sec. 2: $SE\frac{1}{4}$	160.00
Sec. 11: $E\frac{1}{2}$	320.00
Sec. 12: All	640.00
Sec. 13: $N\frac{1}{2}$	320.00
Sec. 14: $N\frac{1}{2}NE\frac{1}{4}$	80.00
Total	5,093.90

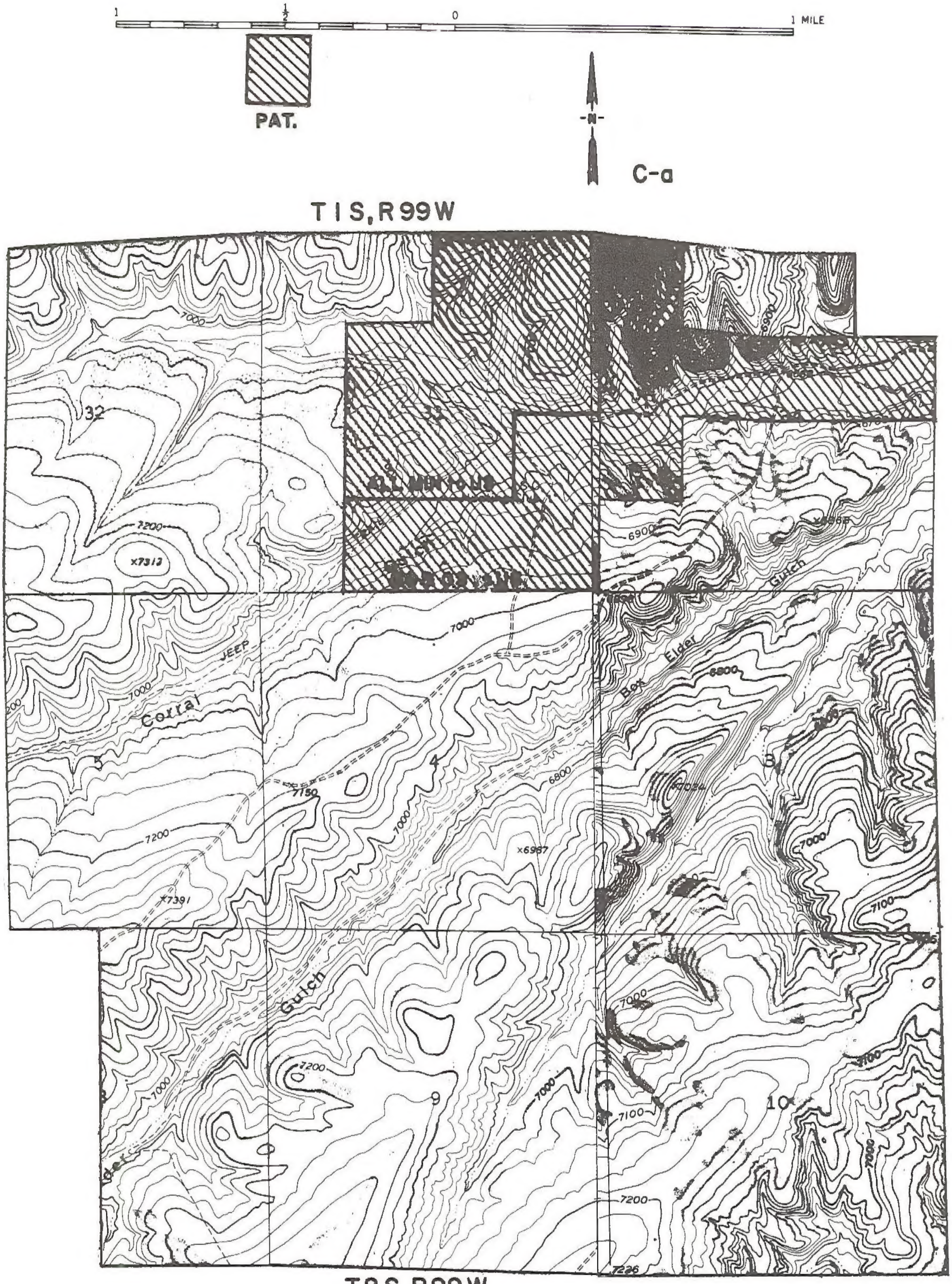


FIGURE II-2.--Topographic Plat of Colorado Tract C-a.

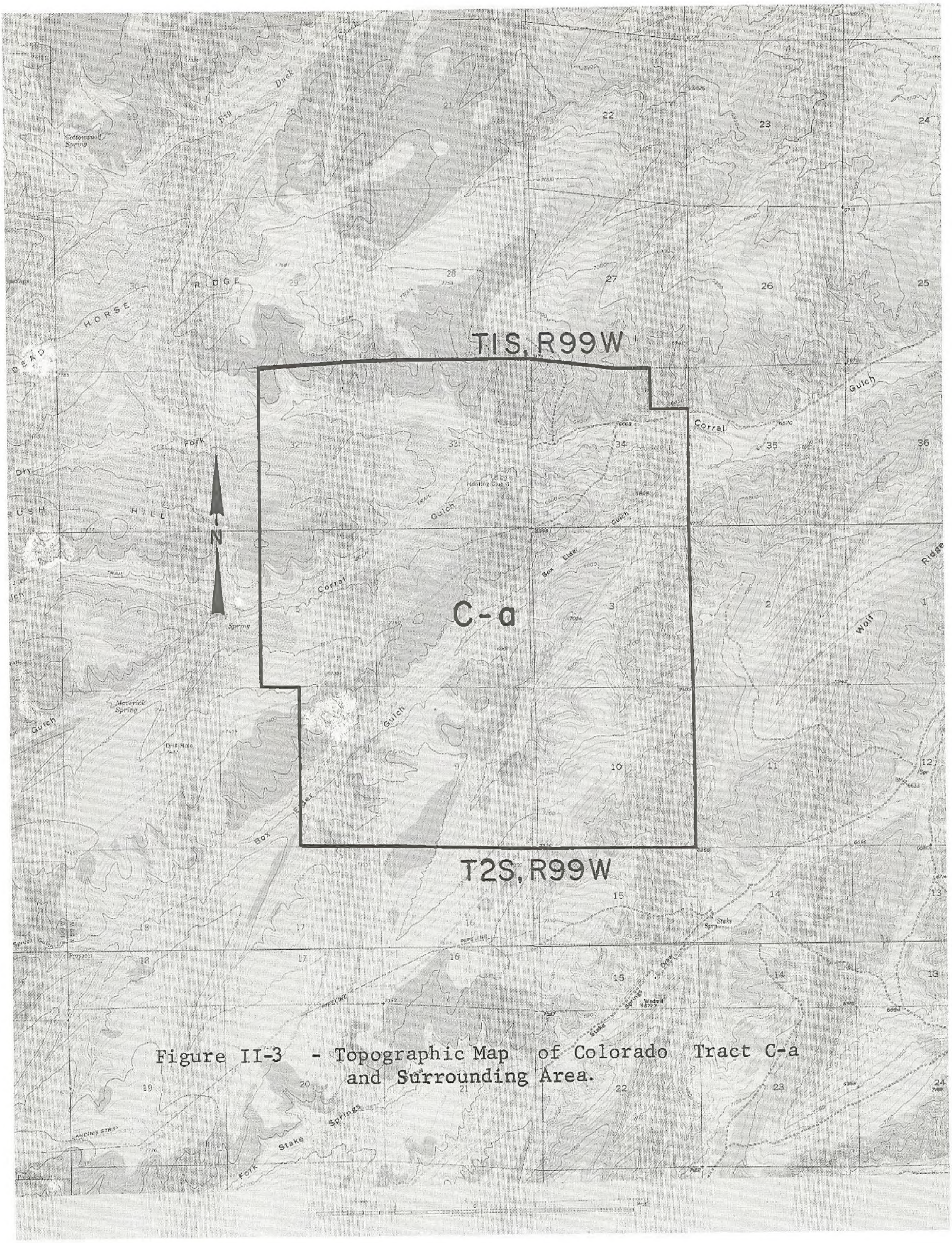


Figure II-3 - Topographic Map of Colorado Tract C-a
and Surrounding Area.

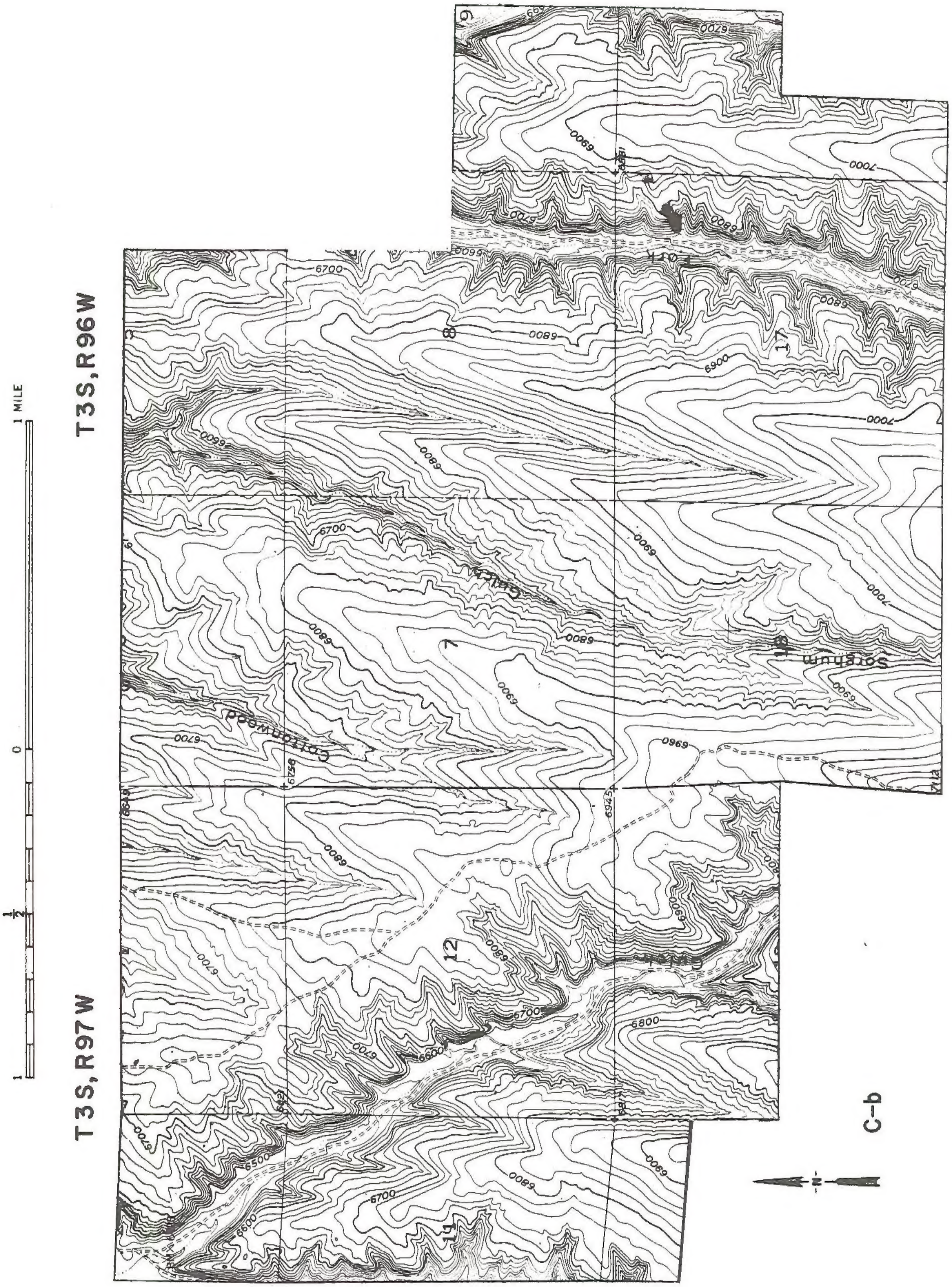


FIGURE II-4.--Topographic Plat of Colorado Tract C-b.

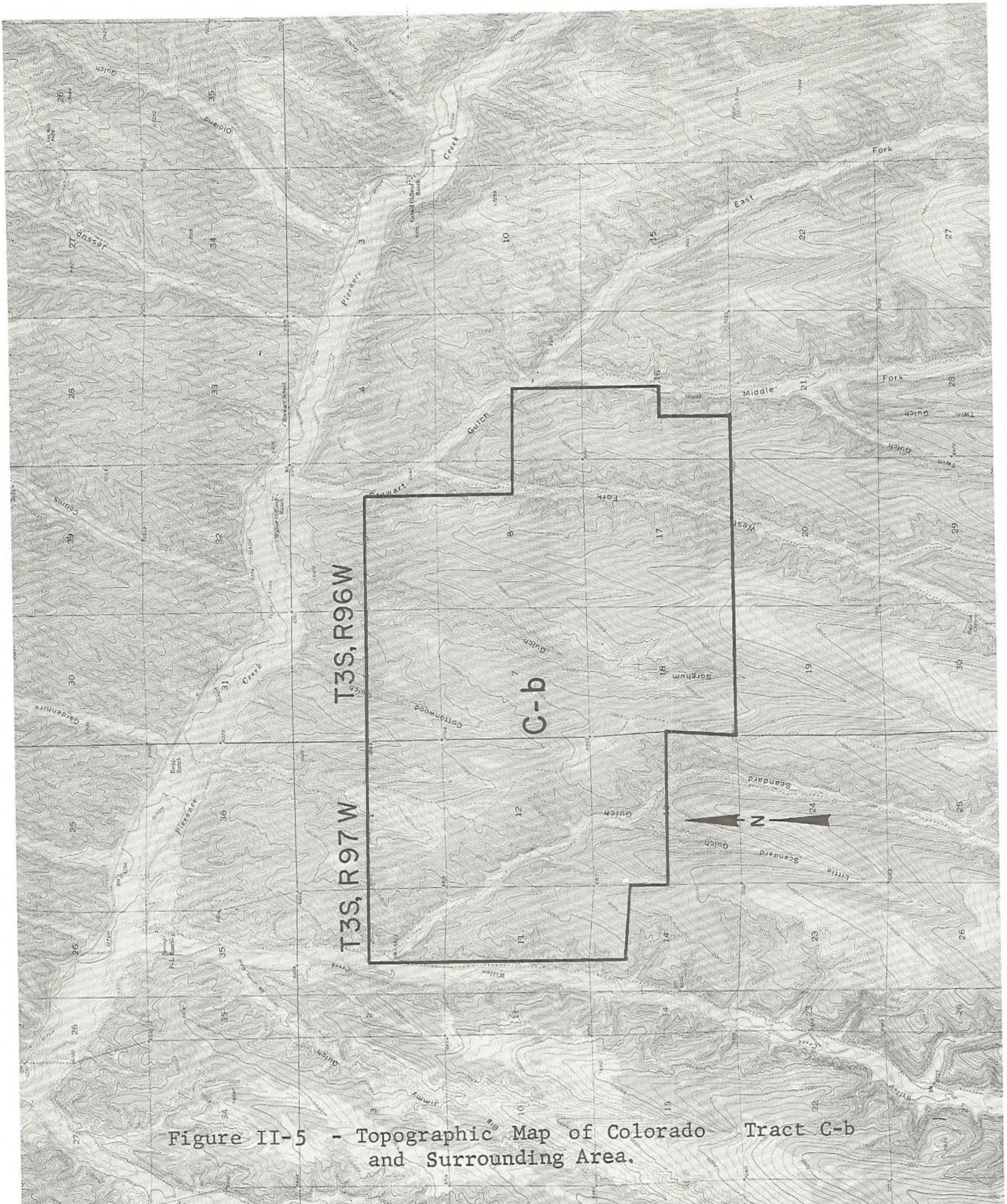


Figure II-5 - Topographic Map of Colorado Tract C-b and Surrounding Area.

TABLE II- 2 .- Principal Features on and Around Colorado Tract C-a

Section		Features
Township 1 South, Range 99 West, Sixth Principal Meridian		
Section-	19:	Cottonwood Spring, unimproved road, jeep trail (Big Duck Creek)
	20:	unimproved road, jeep trail (Big Duck Creek)
	21,22, 23:	no apparent features of significance
	24:	unimproved road
	25:	unimproved road, well
	26:	no apparent features of significance
	27:	unimproved road
	28,29:	jeep trail
	30:	unimproved road, jeep trail (Big Duck Creek)
	31:	unimproved road (Dry Fork)
	32:	(Dry Fork)
	33:	unimproved roads, jeep trail, hunting club (buildings) (Corral Gulch) (Dry Fork)
	34:	unimproved roads
	35:	unimproved roads, building (Corral Gulch)
	36:	unimproved road (Corral Gulch)
Township 1 South, Range 100 West, Sixth Principal Meridian		
Section-	24:	jeep trail
	25:	springs, trail (Big Duck Creek)
	36:	unimproved roads (Dry Fork)

TABLE II-2 .- Principal Features on and Around Colorado Tract C-a (Cont'd)

Township 2 South, Range 99 West, Sixth Principal Meridian		
Section-	1,2:	unimproved road
	3:	(Box Elder Gulch)
	4:	jeep trail, unimproved roads (Box Elder Gulch)
	5:	jeep trail, spring, unimproved road (Corral Gulch)
	6:	jeep trails (Water Gulch) (Corral Gulch)
	7:	Maverick Spring, unimproved road, drill hole
	8:	unimproved roads, trail (Box Elder Gulch)
	9:	unimproved road (Box Elder Gulch)
	10:	no apparent features of significance
	11:	unimproved roads (Stake Springs Draw)
	12:	unimproved roads, 2 springs (Stake Springs Draw)
	13:	unimproved roads
	14:	unimproved roads, Stake Springs (building), (Stake Springs Draw)
	15:	unimproved roads, windmill (Stake Springs Draw)
	16,17:	unimproved roads, pipeline
	18:	prospect, jeep trail (Box Elder Gulch)
	19:	unimproved road, pipeline, landing strip
	20:	unimproved road, pipeline (W. Fork Stake Springs Draw)

TABLE II- 2 .- Principal Features on and Around Colorado Tract C-a (Cont'd)

Township 2 South, Range 99 West, Sixth Principal Meridian (Cont'd)		
Section-	21,22:	unimproved road (Stake Springs and W. Fork Stake Springs Draw)
	23:	unimproved roads
	24:	unimproved roads, ditch along Ryan Gulch
Township 2 South, Range 100 West, Sixth Principal Meridian		
Section-	1:	drill hole, unimproved road, 2 jeep trails (Water Gulch)
	12:	jeep trail, unimproved road
	13:	unimproved roads, jeep trail (Spruce Gulch)
	24:	jeep trail, prospect, unimproved road, trail, landing strip (Box Elder Gulch)

TABLE II-3 .- Principal Features on and Around Colorado Tract C-b

Township 2 South, Range 96 West, Sixth Principal Meridian		
Section-	26:	unimproved road, gas well (Oldland Gulch)
	27:	unimproved road (Jessup Gulch)
	28:	no apparent features of significance
	29:	road, gas well (Collins Gulch)
	30:	(Gardenhire Gulch)
	31:	Piceance Creek and paved road, ditch
	32:	Piceance Creek and paved roads, unimproved road, ditch, flumes, Walter Oldland Ranch (buildings) (Collins Gulch)
	33:	Piceance Creek and road, unimproved road, Stewart School building, ditch
	34:	unimproved road (Jessup Gulch, Oldland Gulch)
	35:	unimproved road (Oldland Gulch)
Township 2 South, Range 97 West, Sixth Principal Meridian		
Section-	25:	Piceance Creek and paved road, unimproved road, ditch (P-L Gulch)
	26:	Piceance Creek and paved road, unimproved road, ditch, marsh
	27:	Piceance Creek and paved road, unimproved road, ditch (Hunter Creek)
	28:	no apparent features of significance
	33:	unimproved road (Hunter Creek)
	34:	unimproved road (Hunter Creek)
	35:	P. L. Ranch (building), springs, Willow Creek, unimproved roads (Big Jimmy Gulch)
	36:	Piceance Creek and paved road, ditch, Redd Ranch (building), unimproved roads

TABLE II-3.- Principal Features on and Around Colorado Tract C-b (Cont'd)

Township 3 South, Range 96 West, Sixth Principal Meridian

Section-	
2:	Piceance Creek and paved road, spring, ditch (Jones Gulch)
3:	Piceance Creek and paved road, unimproved road, ditch (Jessup Gulch)
4:	Piceance Creek and paved road, unimproved road, ditch (Jessup Gulch)
5:	unimproved road (W. Fork and Stewart Gulch)
6:	Piceance Creek
7:	no apparent features of significance
8:	unimproved road (W. Fork Stewart Gulch)
9:	unimproved roads, intermittent lake (Middle Fork, Stewart Gulch)
10:	Piceance Creek
11:	Piceance Creek and paved road, ditch
14:	no apparent features of significance
15:	unimproved road, well, intermittent lake (East Fork Stewart Gulch)
16:	unimproved road, ditch, intermittent lake (Middle Fork Stewart Gulch)
17:	unimproved road (W. Fork)
18:	unimproved road
19:	no apparent features of significance
20:	unimproved road, intermittent lake (W. Fork)
21:	unimproved road (Middle Fork)
22:	unimproved road, intermittent lake (East Fork)
23:	(East Fork)

TABLE II- 3 .- Principal Features on and Around Colorado Tract C-b (Cont'd)

Township 3 South, Range 96 West, Sixth Principal Meridian (Cont'd)		
Section-	26:	unimproved road (East Fork)
	27:	no apparent features of significance
	28:	unimproved road (Middle Fork)
	29:	unimproved roads (W. Fork)
	30:	unimproved roads, Redd Cow Camp, marsh (W. Fork)
Township 3 South, Range 97 West, Sixth Principal Meridian		
Section-	1:	unimproved roads
	2:	unimproved roads (Willow Creek, Scandard Gulch)
	3:	(Big Jimmy Gulch)
	4:	unimproved road (Hunter Creek)
	9:	unimproved roads, buildings (Enoch Gulch) (Hunter Creek)
	10:	(Big Jimmy Gulch)
	11:	unimproved roads (Willow Creek)
	12:	unimproved roads (Scandard Gulch)
	13:	unimproved roads (Little Scandard and Scandard Gulch)
	14:	unimproved road, intermittent lake (Willow Creek)
	15:	no apparent features of significance
	16:	unimproved road (Enoch Gulch) (Big Jimmy Gulch)
	21:	(Big Jimmy Gulch)
	22,23:	unimproved road (Willow Creek)
	24:	unimproved road (Little Scandard and Scandard Gulch)

TABLE II-3 .- Principal Features on and Around Colorado Tract C-b (Cont'd)

Township 3 South, Range 97 West, Sixth Principal Meridian (Cont'd)		
Section-	25:	unimproved roads, well (Scandard Gulch)
	26:	(Little Scandard Gulch)
	27:	unimproved road, buildings (Willow Creek)
	28:	(Big Jimmy Gulch)

FIGURE II-6.--Typical Aerial View of Colorado Tract C-a.

FIGURE II-7.--Typical Aerial View of Colorado Tract C-b.

2. Selected Utah Tracts

a. Description

Two sites, both in Uintah County, Utah, and adjacent to one another, have been selected from the nominations and are hereinafter designated as Tracts U-a and U-b. The legal descriptions of the tracts are given in Table II-4. Topographic plats are shown in Figures II-8 to II-11, principal features on and around the tracts are listed in Table II-5, and typical aerial views of the two sites in Figures II-12 and II-13.

b. Land Status, Tracts U-a and U-b

Surface and mineral rights on both of these tracts are owned by the United States, except for a portion of Tract U-b as follows: Township 10 South, Range 24 East, Section 14, NW¼NW¼ (Fig. II-10), surface is owned by LaRue Pickup and others; oil and gas and oil shale are reserved to the United States.

An improved, unsurfaced county road passes through the northeast corner of Tract U-b. An unimproved truck trail passes through both tracts, connecting the county road in the northeast corner of Tract U-b with an unimproved road running along West Fork Asphalt Wash.

A gilsonite slurry pipeline and an electric powerline run through sections 12, 13, and 19 of Tract U-b in a northwest to southeast direction, from Bonanza, Utah, to Fruita and Grand Junction, Colorado, respectively. Two small collection gas pipelines are located in Southam Canyon Tract U-a. A woven wire sheep holding corral is situated near the northwest corner of section 25 in Tract U-b and a small cattle handling corral is located in the southwest quarter, section 21 of Tract U-a, in Southam Canyon.

TABLE II-4.--Legal Description of the Two Utah Oil Shale Tracts.

	Acres
Tract U-a:	
T. 10 S., R. 24 E., SLM:	
Sec. 19: E½	320.00
Sec. 20: All	640.00
Sec. 21: All	640.00
Sec. 22: All	640.00
Sec. 27: All	640.00
Sec. 28: All	640.00
Sec. 29: All	640.00
Sec. 30: E½	320.00
Sec. 33: N½	320.00
Sec. 34: N½	320.00
Total	5,120.00
Tract U-b:	
T. 10 S., R. 24 E., SLM:	
Sec. 12: S½, S½N½	480.00
Sec. 13: All	640.00
Sec. 14: All	640.00
Sec. 23: All	640.00
Sec. 24: All	640.00
Sec. 25: W½W½	160.00
Sec. 26: All	640.00
T. 10 S., R. 25 E., SLM:	
Sec. 18: All	640.00
Sec. 19: All	640.00
Total	5,120.00

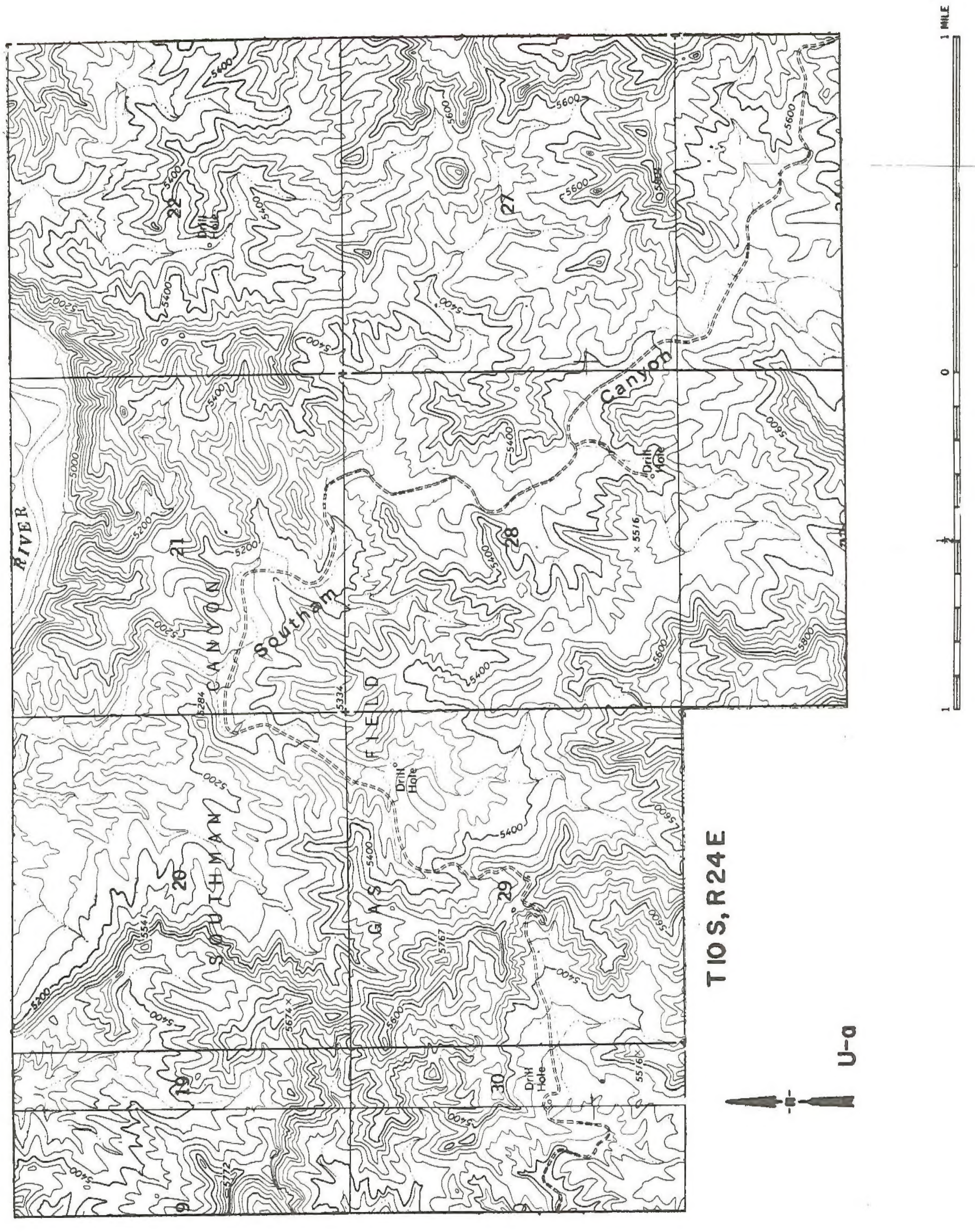


FIGURE II-8.--Topographic Plat of Utah Tract, U-a.

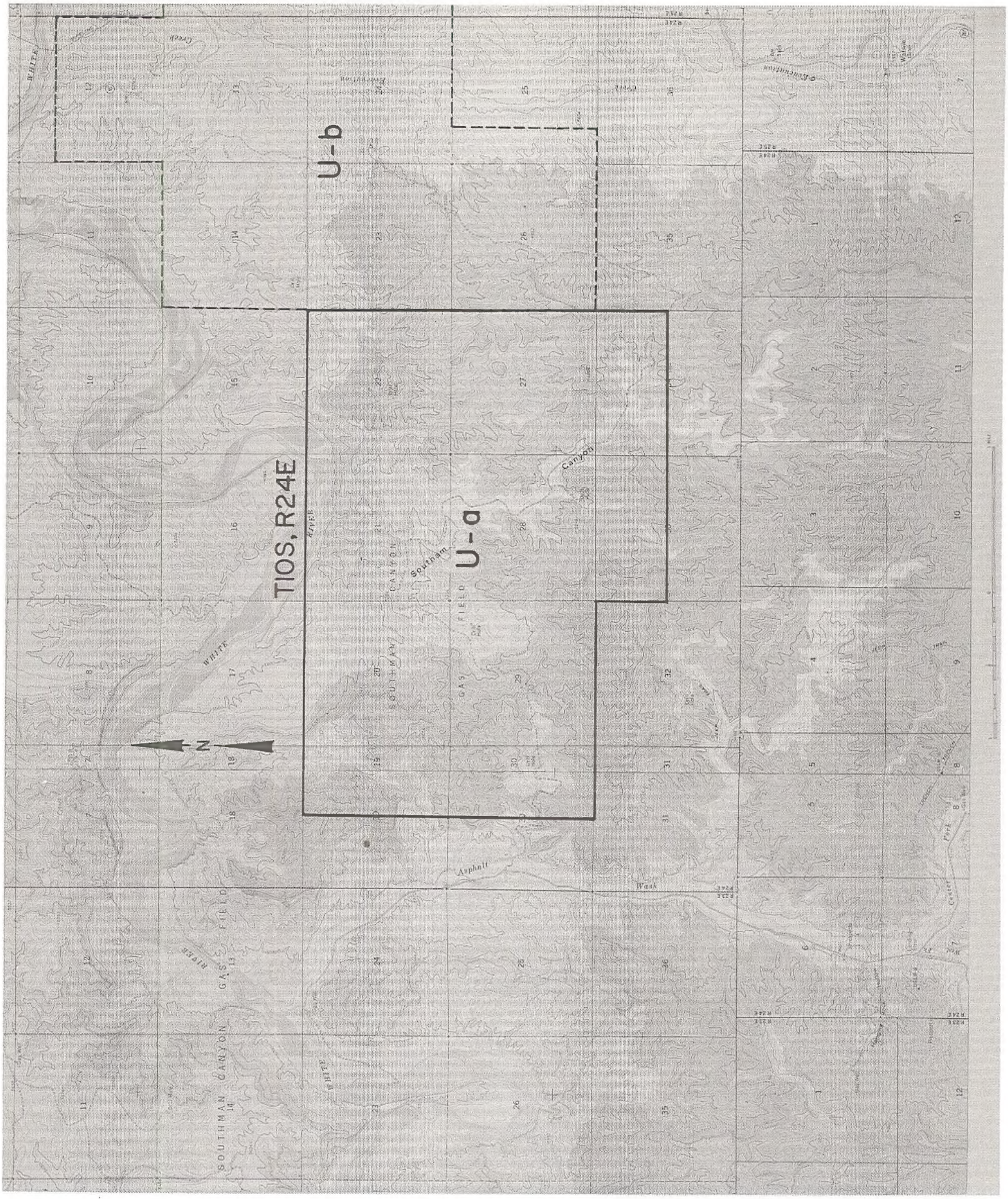


Figure II-9 - Topographic Map of Utah Tract U-a
and Surrounding Area.

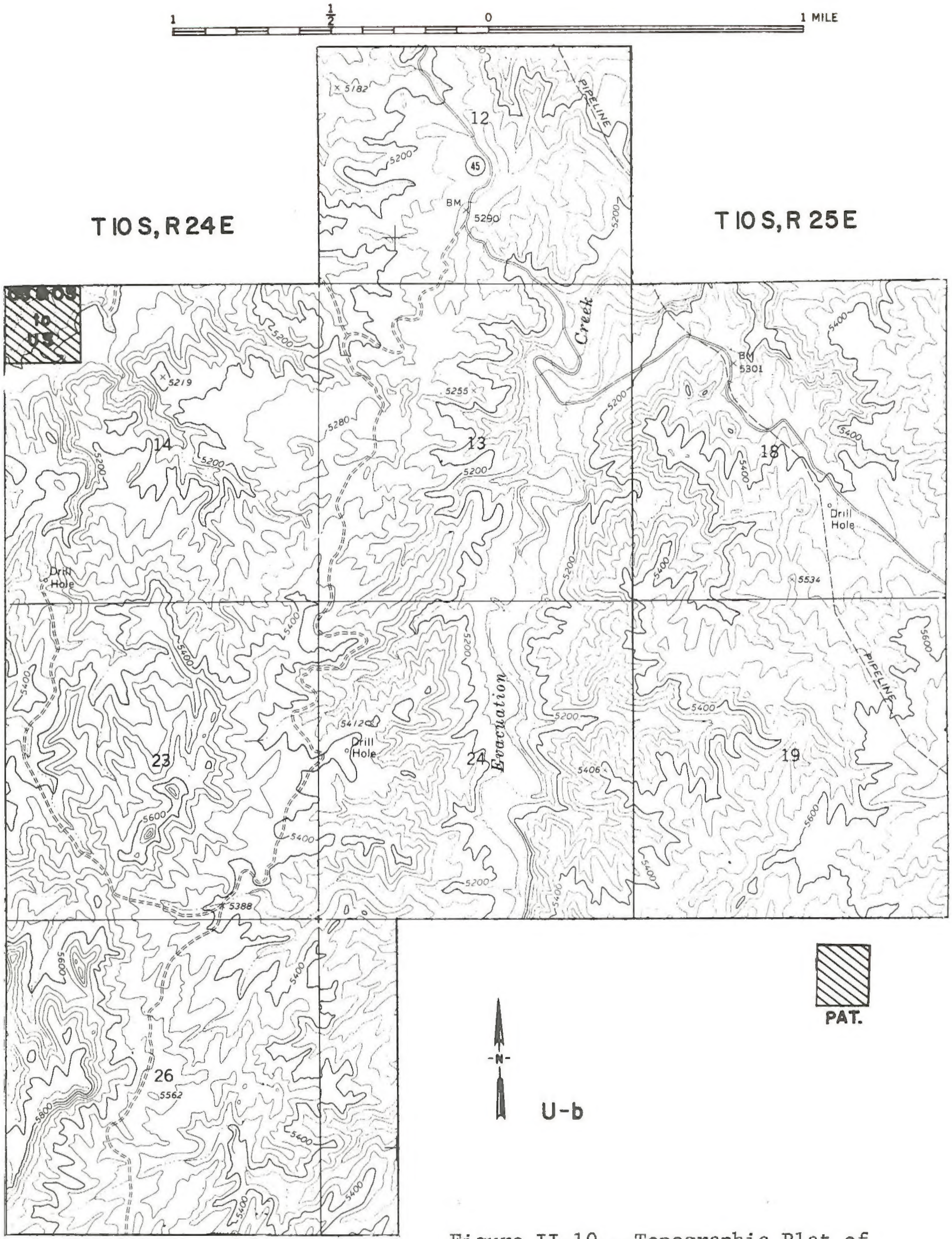


Figure II-10.--Topographic Plat of Utah Tract U-b.

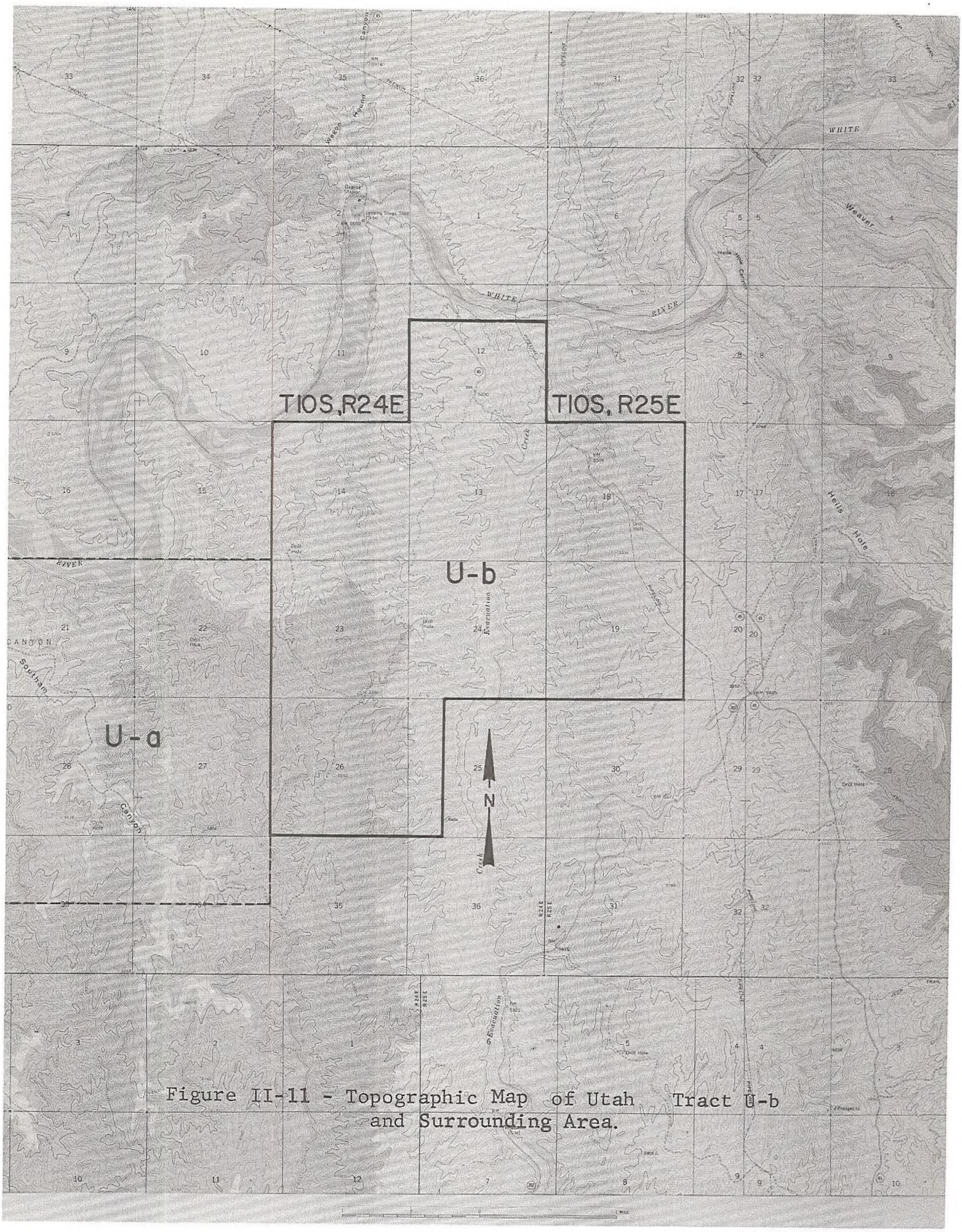


Figure II-11 - Topographic Map of Utah Tract U-b and Surrounding Area.

TABLE II-5 .- Principal Features on and Around Utah Tracts U-a and U-b

Township 9 South, Range 24 East, Salt Lake Meridian		
Section-	33:	unimproved road, gilsonite trench, shaft
	34:	unimproved roads, gilsonite trench, shaft
	35:	unimproved road, gilsonite trench, shaft, State road 45 (Wagon Hound Canyon)
	36:	gilsonite trench
Township 9 South, Range 25 East, Salt Lake Meridian		
Section-	31:	unimproved road, pipeline
	32:	unimproved road, pipeline, White River
	33:	jeep trail, White River
Township 10 South, Range 23 East, Salt Lake Meridian		
Section-	11:	gas well, unimproved roads
	12:	(White River)
	13:	White River, Southman Canyon gas field
	14:	drill hole, Southman Canyon gas field, unimproved roads, White River
	23:	White River, unimproved road, building
	24:	gas well, road, unimproved road (Asphalt Wash)
	25:	no apparent features of significance
	26:	White River
	35:	no apparent features of significance
	36:	road (Asphalt Wash)
Township 10 South, Range 24 East, Salt Lake Meridian		
Section-	1:	White River, unimproved road, pipeline
	2:	White River, Ignatio Stage Stop (site), gaging station, wells, State Road 45, unimproved road

TABLE II- 5 .- Principal Features on and Around Utah Tracts U-a and U-b (Cont'd)

Township 10 South, Range 24 East, Salt Lake Meridian (Cont'd)

Section-		
	3:	gilsonite trench, shafts, road, unimproved roads, USLM 12
	4:	unimproved road
	7:	White River
	8:	White River, unimproved road
	9:	White River, unimproved road
	10,11:	White River
	12:	White River, State Road 45, pipeline, unimproved road
	13:	unimproved roads State Road 45, (Evacuation Creek)
	14:	White River, drill hole
	15,16:	White River
	17:	White River, unimproved road
	18:	White River
	19:	(Asphalt Wash)
	20:	unimproved road, Southman Canyon gas field
	21:	unimproved road, Southman Canyon gas field, White River
	22:	drill hole
	23:	unimproved roads (Evacuation Creek)
	24:	drill hole (Evacuation Creek)
	25:	(Evacuation Creek)
	26,27:	unimproved road
	28,29:	unimproved road, drill hole, Southman Canyon gas field

TABLE II-5 .- Principal Features on and Around Utah Tracts U-a and U-b (Cont'd)

Township 10 South, Range 24 East, Salt Lake Meridian (Cont'd)		
Section-	30:	road, unimproved road, drill hole (Asphalt Wash)
	31:	(Asphalt Wash)
	32:	drill hole, jeep trail
	33:	no apparent features of significance
	34,35:	unimproved road
	36:	road (Evacuation Creek)
Township 10 South, Range 25 East, Salt Lake Meridian		
Section-	4:	unimproved road, pipeline (Weaver Canyon)
	5:	White River, pipeline (Hells Hole Canyon)
	6:	unimproved roads, pipeline
	7:	White River, pipeline (Evacuation Creek)
	8:	unimproved road (Hells Hole Canyon)
	9:	unimproved road
	16:	unimproved road (Hells Hole Canyon)
	17:	unimproved roads (Hells Hole Canyon)
	18:	State Road 45, drill hole, pipeline
	19:	pipeline
	20:	State Roads 45 & 207, pipeline, unimproved roads
	21:	unimproved road (Hells Hole Canyon)
	28:	State Road 45, jeep trail, drill hole, unimproved road
	29:	State Roads 45 & 207, pipeline, unimproved road

TABLE II- 5 .- Principal Features on and Around Utah Tracts U-a and U-b (Cont'd)

<u>Township 10 South, Range 25 East, Salt Lake Meridian</u> (Cont'd)

<u>Section-</u>

30:	State Road 207
31:	State Road 207, unimproved roads
32:	unimproved road, pipeline
33:	State Road 45

<u>Township 11 South, Range 23 East, Salt Lake Meridian</u>

<u>Section-</u>

1:	gas well, unimproved road (Hanging Rock Hollow)
1,2:	no apparent features of significance
3,4:	jeep trail
5:	no apparent features of significance
6:	road, well, prospects (Hanging Rock Hollow) (Asphalt Wash)
7:	roads, USLM 8, landing strip (W. Fork, Center Fork Asphalt Wash)
8:	road, gas well, USLM 10, trench, unimproved road (Center Fork)
9:	jeep trail, trench
10,11,12:	no apparent features of significance

<u>Township 11 South, Range 25 East, Salt Lake Meridian</u>

<u>Section-</u>

3:	State Road 45, prospects, jeep trail, unimproved road
4:	pipeline
5:	unimproved road, drill hole
6:	State Road 207 (Evacuation Creek)
7:	State Road 207 (Watson site) (Evacuation Creek)
8:	unimproved road
9:	unimproved road, pipeline
10:	State Road 45

Figure II-12.--Typical Aerial View of Utah Tract U-a.

FIGURE II-13.--Typical Aerial View of Utah Tract U-b

3. Selected Wyoming Tracts

a. Description

Two adjacent sites, both in Sweetwater County, Wyo. have been selected from the nominations and are designated hereinafter as Tracts W-a and W-b. The legal descriptions of the tracts are given in Table II-6 Topographic plats are shown in Figures II-14 to II-17, principal features on and around the tracts are listed in Table II-7, and typical aerial views of the two tracts in Figures II-18 and II-19.

b. Land Status, Tracts W-a and W-b

All surface and mineral rights on both of these tracts are owned by the United States.

An unimproved road passes through the northern end of Tract W-a, in a southwest to northeast direction. There are no other man-made improvements on either Tract W-a or W-b. Carson Spring, a developed livestock watering facility is situated near this road, approximately three-quarters of a mile northeast from Tract W-a.

TABLE II-6.--Legal Description of the Two Wyoming Oil Shale Tracts.

	Acres
Tract W-a:	
T. 14 N., R. 99 W., 6th PM:	
Sec. 17: All........................	640.00
Sec. 18: All........................	631.24
Sec. 19: NE¼........................	160.00
Sec. 20: All........................	640.00
Sec. 21: All........................	640.00
Sec. 22: All........................	640.00
Sec. 27: All........................	640.00
Sec. 28: All........................	640.00
Sec. 29: N½, SE¼....................	480.00
Total...........................	5,111.24
Tract W-b:	
T. 13 N., R. 99 W., 6th PM:	
Sec. 1: S½, S½N½, Lot 1, Lot 3, Lot 4	601.03
Sec. 2: All........................	642.15
Sec. 3: All........................	640.36
Sec. 4: Lot 1, SE¼NE¼................	79.70
Sec. 10: E½, E½NW¼..................	400.00
Sec. 11: All........................	640.00
Sec. 12: All........................	640.00
T. 14 N., R. 99 W., 6th PM:	
Sec. 33: E½E½........................	160.00
Sec. 34: All........................	640.00
Sec. 35: All........................	640.00
Total...........................	5,083.24

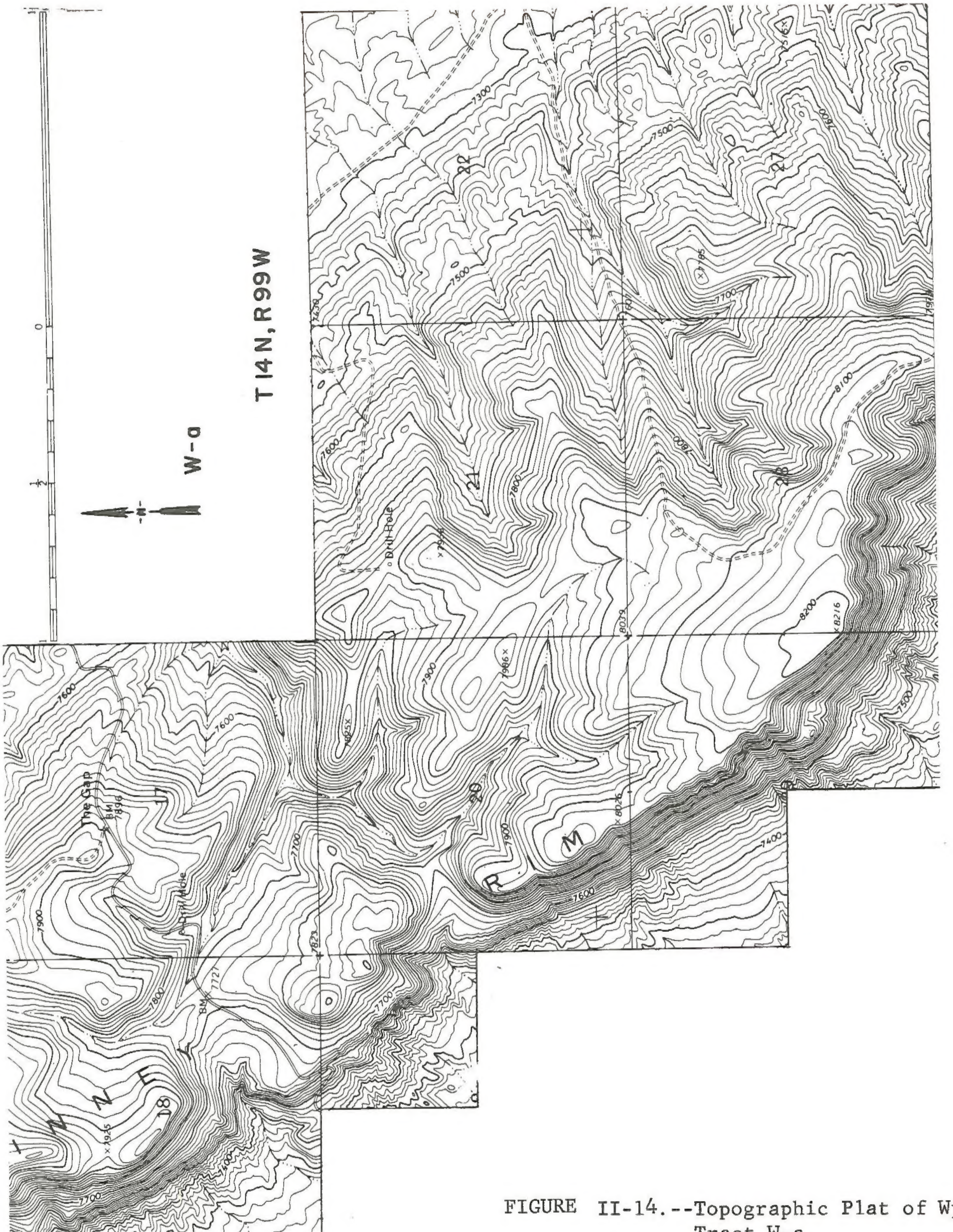


FIGURE II-14.--Topographic Plat of Wyoming Tract W-a.

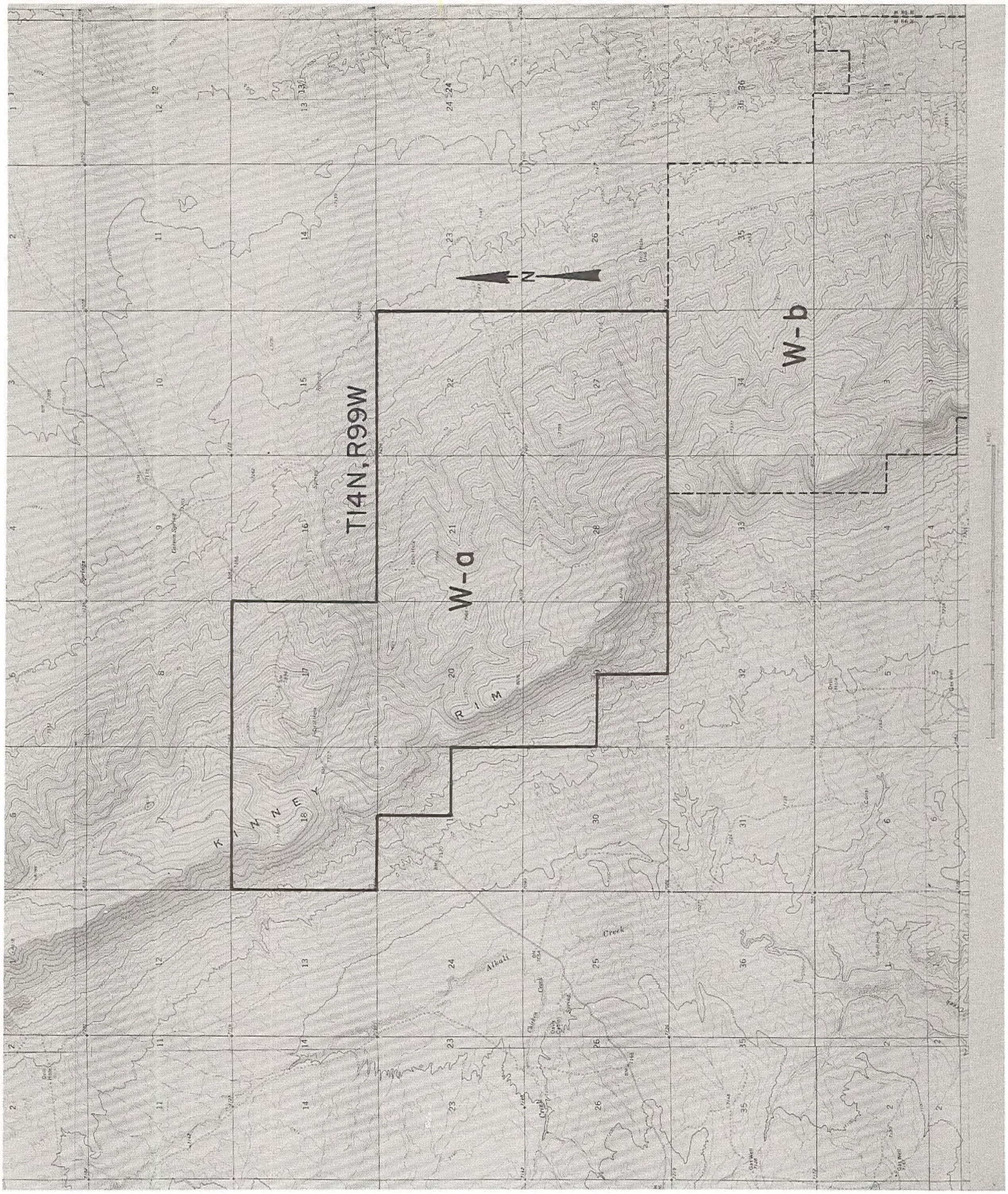


Figure II-15 - Topographic Map of Wyomin[illegible] Tract W-a
and Surrounding Area.

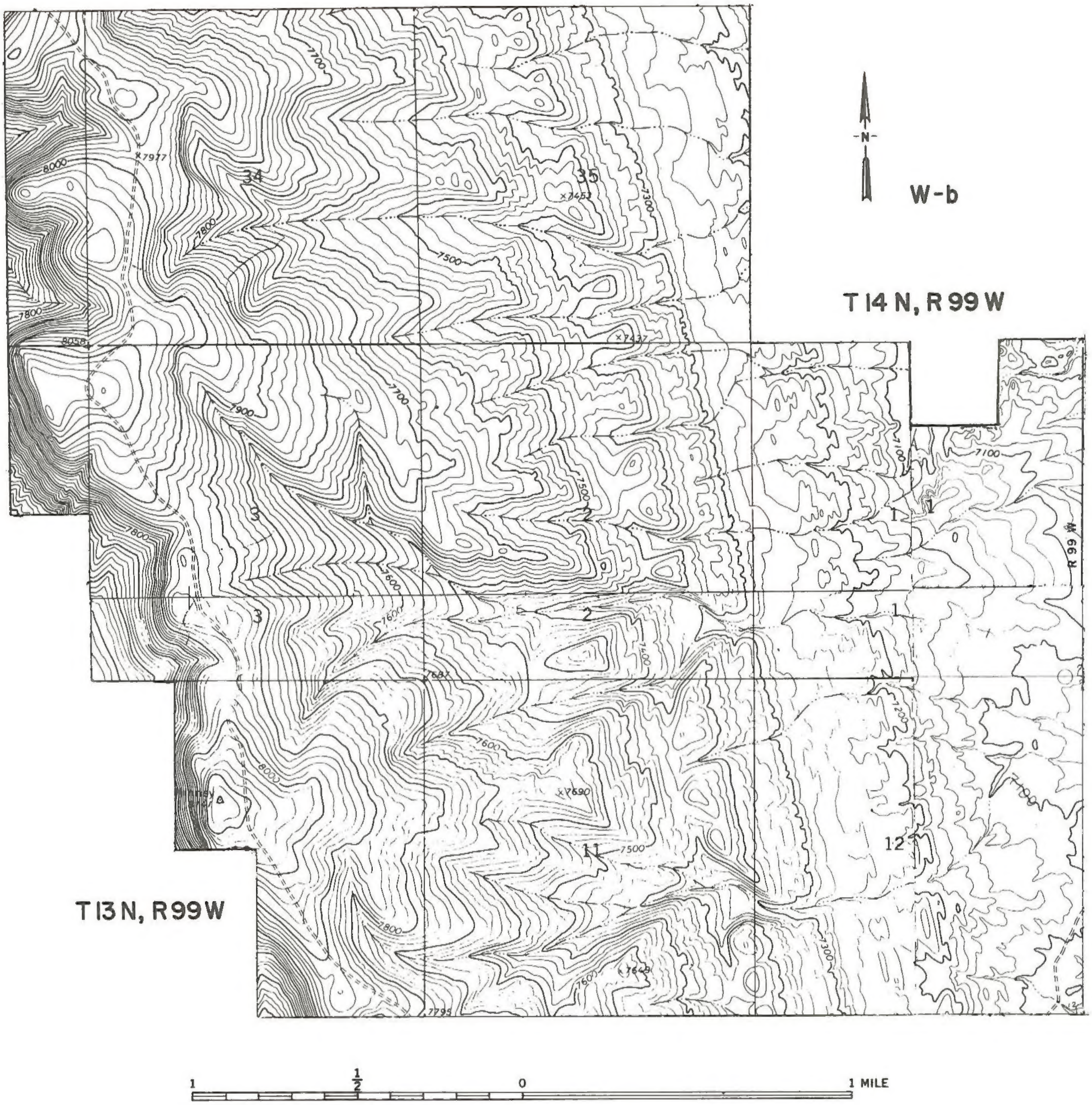


FIGURE II-16. -- Topographic Plat of Wyoming Tract W-b.

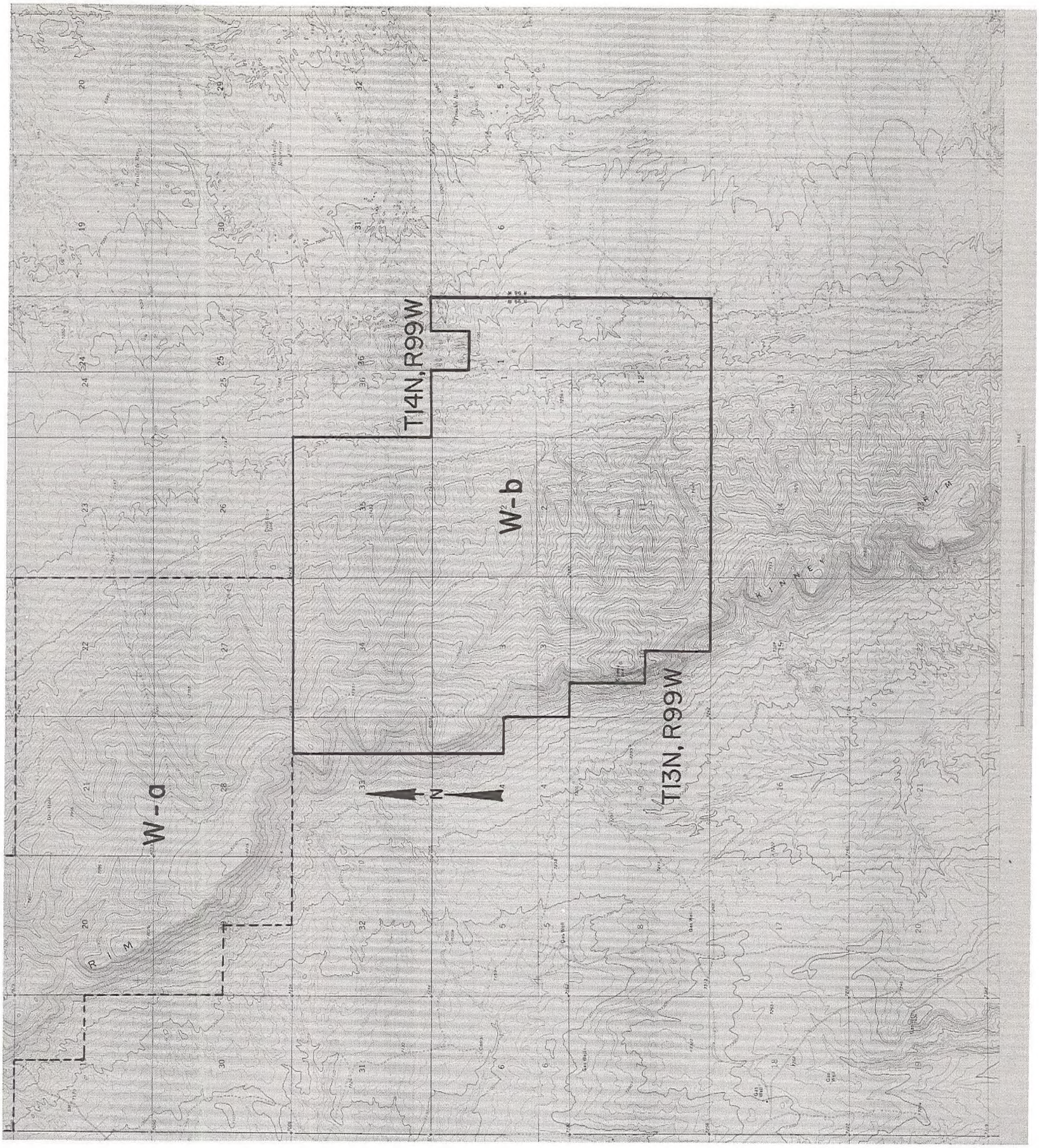


Figure II-17 - Topographic Map of Wyoming Tract W-b
and Surrounding Area.

TABLE II- 7.- Principal Features on and Around Wyoming Tracts W-a and W-b

Township 13 North, Range 98 West, Sixth Principal Meridian		
Section-	5:	Trouble Reservoir
	6,7:	unimproved road
	8:	intermittent lake
	17:	unimproved road, intermittent lake
	18:	unimproved road, spring
	19:	no apparent features of significance
	20:	unimproved road
Township 13 North, Range 99 West, Sixth Principal Meridian		
Section-	1,2:	no apparent features of significance
	3,4:	unimproved road (Kinney Rim)
	5:	roads, drill hole, gas well, unimproved roads, reservoir
	6:	unimproved roads (Corral)
	7:	gas well
	8:	roads, unimproved roads, gas well
	9:	unimproved roads
	10:	unimproved roads (Rim)
	11:	no apparent features of significance
	12:	unimproved road
	13:	unimproved roads, spring (Rim) intermittent lake
	14:	unimproved road (Rim)
	15:	unimproved roads (Rim), small pond
	16:	no apparent features of significance
	17:	unimproved road, road

TABLE II-7 .- Principal Features on and Around Wyoming Tracts W-a and W-b (Cont'd)

Township 13 North, Range 99 West, Sixth Principal Meridian (Cont'd)		
Section-	18:	roads, unimproved road, gas wells, tank
	19:	unimproved road, gas well, road
	20:	road, unimproved road
	21:	no apparent features of significance
	22:	(Rim)
	23:	unimproved road, trail (Rim)
	24:	unimproved road
Township 14 North, Range 98 West, Sixth Principal Meridian		
Section-	19:	no apparent features of significance
	20:	unimproved road, Trailside Reservoir
	29:	unimproved road, jeep trail
	30:	unimproved road, Guthridge Reservoir, jeep trail
	31,32:	unimproved roads
Township 14 North, Range 99 West, Sixth Principal Meridian		
Section-	1:	unimproved road
	2:	unimproved road, road
	3:	unimproved road, road
	4:	springs, unimproved road
	5:	unimproved roads
	6:	unimproved road
	7:	unimproved road (Rim)
	8:	unimproved road
	9:	road, Carson Spring, small reservoir, several springs, unimproved roads

TABLE II-7.- Principal Features on and Around Wyoming Tracts W-a and W-b (Cont'd)

Township 14 North, Range 99 West, Sixth Principal Meridian (Cont'd)

Section-	
10:	unimproved road, road
11,12,13,14:	no apparent features of significance
15:	2 springs, unimproved roads
16:	road, spring, unimproved road
17:	road, unimproved road, drill hole
18:	road (Rim)
19:	intermittent lake, road (Rim)
20:	(Rim)
21:	drill hole, unimproved road
22:	2 unimproved roads
23:	unimproved roads
24:	no apparent features of significance
25:	unimproved road
26:	unimproved road, drill hole
27:	no apparent features of significance
28:	unimproved road (Rim)
29:	(Rim)
30:	unimproved road
31:	unimproved roads, reservoir
32:	no apparent features of significance
33:	unimproved road (Rim)
34:	unimproved road
35:	no apparent features of significance
36:	unimproved road

TABLE II- 7.- Principal Features on and Around Wyoming Tracts W-a and W-b (Cont'd)

Township 14 North, Range 100 West, Sixth Principal Meridian		
Section-	1:	unimproved road, trail (Rim)
	2:	drill hole, unimproved roads
	11:	unimproved road, trail (Alkali Creek)
	12:	trail (Rim)
	13:	unimproved road, trail (Alkali Creek)
	14:	unimproved road (Alkali Creek)
	23:	unimproved road
	24:	trail, unimproved road, road (Alkali Creek)
	25:	unimproved roads, Davis Cabin, spring, road (Chicken Creek, Alkali Creek)
	26:	unimproved roads, road, intermittent lake (Chicken Creek)
	35:	gas well, unimproved roads
	36:	unimproved road (Alkali Creek)
Township 13 North, Range 100 West, Sixth Principal Meridian		
Section-	1:	drill hole, unimproved road, (Alkali Creek)
	2:	unimproved roads, gas well, road

FIGURE II-18.--Typical Aerial View of Wyoming Tract W-a.

Figure II-19.--Typical Aerial View of Wyoming Tract W-b.

B. Description of the Environment

1. Colorado Tract C-a (Piceance Creek Basin)

a. Physiography

Tract C-a is located on the west flank of the Piceance Creek Basin. The topography of the area (Figure II-2) is characterized by northeast-trending subparallel canyons and ridges. The slopes of the canyon walls are steep with a few ledges of oil shale breaking the slopes. The valley floors are narrow and the ridges are broad and rounded and both slope gently northeastward. Altitudes within the tract range from about 6,600 feet on Corral Creek near the northeast corner to about 7,400 feet on a ridge in the southwestern part. Greatest relief between valley bottom and nearby ridgetop is about 300 feet. Photographs of the area are shown in Figures II-20 to II-22.

Figure II-20.--Oblique Aerial View Tract C-a, Colorado. A general view looking northeast down Box Elder Gulch in the eastern half of the Tract.

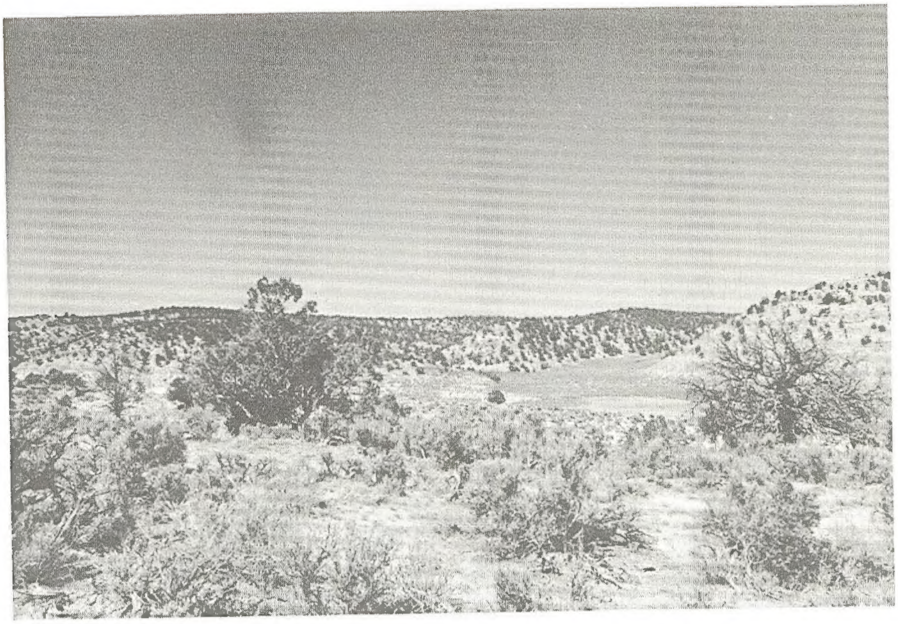


Figure II-21. Ground view, Tract C-a, Colorado, showing characteristic land surface and vegetation.

Figure II-22. Ground view, Tract C-a, Colorado, looking eastward toward the proposed spent shale disposal area on east Douglas Creek.

b. Climate

Tract C-a is located in an area in which the climate is classified as semiarid with annual average precipitation amounts ranging from about 10 inches to a maximum of 18 inches, depending on altitude. The total number of days with precipitation amounts greater than 0.1 inches is about 40. Approximately one-half of the annual precipitation occurs as snow. Accumulated snow depth on higher terrain may exceed 3 feet for short time periods. Precipitation during the warmer months occurs mainly with local thunderstorms that are more frequent over higher terrain. Thunderstorms are often severe with strong, local, gusty winds and high precipitation rates causing local flash flooding.

The mean maximum temperature in January is about 38°F and the mean minimum about 5°F. The highest recorded in January is 60°F and the lowest is -35°F. The mean maximum temperature in July is about 86°F and the mean minimum about 45°F. The highest recorded in July is 98°F and the lowest is 30°F. The frost free period is approximately 90 days.

Prevailing winds are from a southwesterly direction, but gusty winds may occur from other directions depending on large-scale atmospheric circulation. Local topographic features have a strong influence on wind flow and create well organized mountain and valley wind flow patterns (Volume I, Chapter II). In all seasons when local flow

regimes predominate, the most frequent wind direction is from the northeast (upslope) during the warmer part of the day; and the most frequent direction during the colder part of the day is from the southwest.

Night temperature inversions occur with high 90%-60% frequency over the Piceance Creek Basin in the lower few hundred meters above the terrain because of strong radiative cooling in a rather dry atmosphere.

c. Geology and Mineral Resources

Tract C-a located on surface rocks that are entirely in the Green River formation. The general geology of the Green River formation is described in section II of Volume I of the Environmental Statement. Details for the tract are given below, and a section across the tract is shwon in Figure II-23.

The strike of the beds in Tract C-a is in general to the north, and the dip is generally to the east and ranges from 400 feet per mile in the western part of the tract to 300 feet per mile in the eastern part. A northwest-trending graben bisects the area. Maximum measured fault displacement is 175 feet.

The tract contains about 60 feet of shale in the Mahogany Zone, which averages 30 gallons or more of oil per ton. About 435 feet of shale in the lower oil-shale zone averages 30 gallons of oil per ton. The total in-place shale oil resource in the two zones in beds 10 feet thick or more averages about 1,000,000 barrels per acre. Overburden above the Mahogany Zone in the tract ranges from as little as 100 feet to

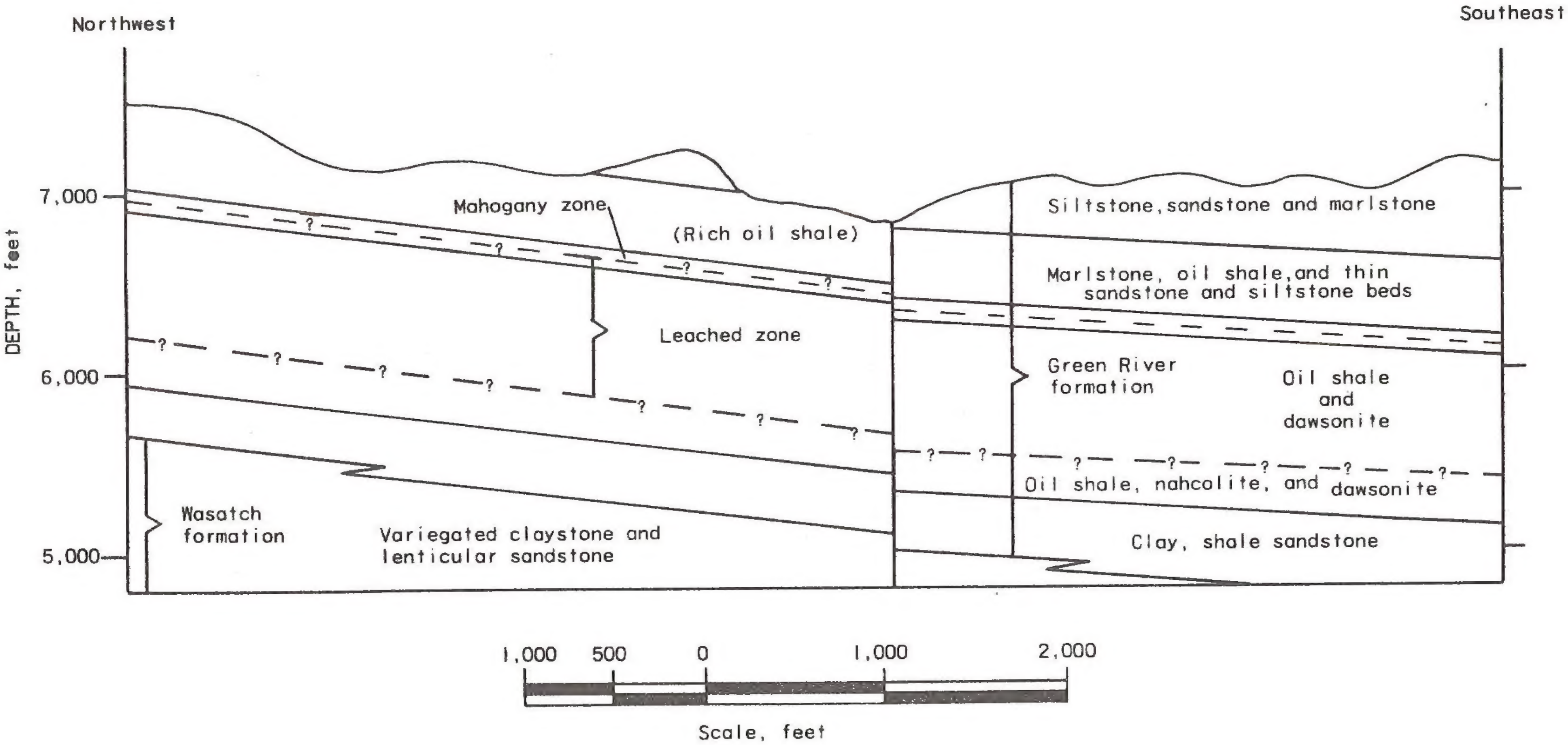


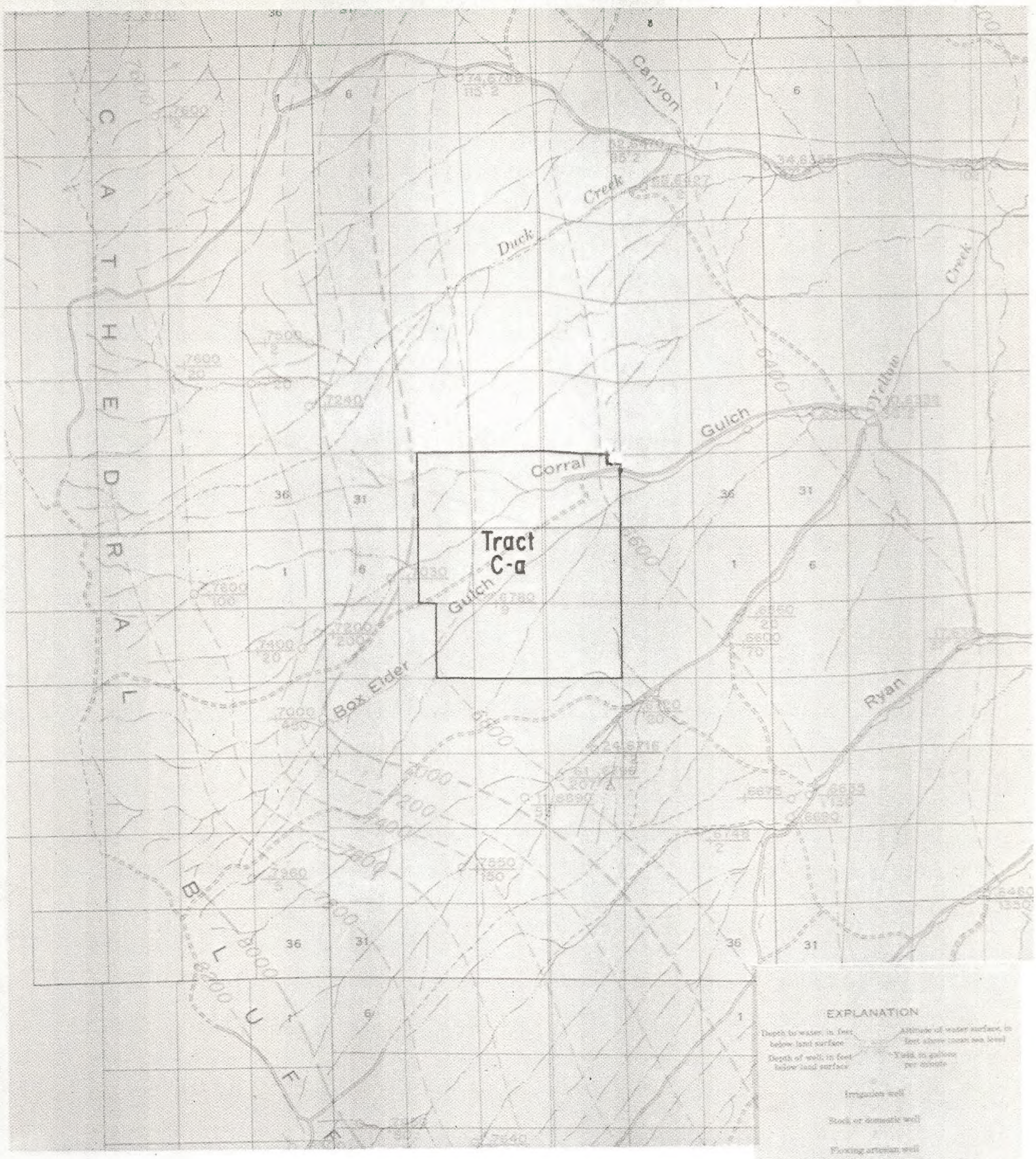
Figure II-23.-Generalized Cross Section for Tract C-a, Colorado

as much as 850 feet and averages about 450 feet. The shale oil resource of approximately 30 gallons per ton recoverable from the tract by surface mining methods is estimated to be 4.07 billion barrels. Nahcolite that is present within the mineable oil shale sequence does not occur in beds but in pods. Dawsonite probably is present in varying amounts in about 500 feet of section in the lower oil shale zone. No oil or gas has been found on Tract C-a; however, commercially significant amounts of gas and small amounts of oil have been produced from the Douglas Creek Member of the Green River formations elsewhere in the Piceance Creek Basin. The Fort Union and Mesa Verde formations being considered in the Rio Blanco gas stimulation proposal underlie the entire tract at a depth of 2,000 or more feet below the base of the oil shale.

d. Water Resources

Tract C-a is drained by tributaries of Yellow Creek. Corral Gulch and Box Elder Gulch cut diagonally through the tract from southwest to northeast. They do not sustain streamflow except during periods of snowmelt and runoff from thunderstorms. However, the water table is shallow enough in most reaches of their valleys to support a growth of phreatophytes. Well locations and the altitude of the water table in the vicinity of Tract C-a are given in figure II-24.

Small to moderate quantities of ground water, perhaps as much as 100 gallons per minute (about 0.2 cfs) could be pumped for a few days or a few weeks from the alluvium along the creeks. A water supply of several hundred gallons per minute per well could be developed from the two water-bearing zones in the Green River



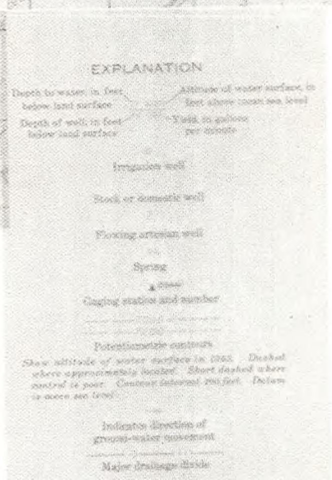


Figure II-24. - Ground Water Map of Tract C-a and Surrounding Area.

Source: Reference (1).

SCALE 1:125 000

2 0 2 4 6 8 10 MILES

2 0 2 4 6 8 10 KILOMETERS

formation. Data suggest that water in the lower part of the leached zone is more saline than the water above and that permeability of the lower part generally is greater than that of the upper part of the leached zone. The potentiometric surface indicates that a possibility of flowing wells exists in the lowest areas near the northeast corner of the tract. Elsewhere in the tract, the depth to water ranges from 30 to 60 feet in the upper water-bearing zone and from 100 to 450 feet in the lower zone. Head differences between the two zones may be as much as 130 feet.

The specific conductance of water in the upper zone ranges from less than 1,00- micromhos to at least 1,400 micromhos. The specific conducatnce of water in the lower zone ranges from 2,000 to at least 20,000 micromhos.

Data from core holes drilled on and near Tract C-a suggest that the transmissivity of the water-bearing zones ranges from 3,100 to 21,000 gpd per foot and averages about 10,000 gpd per foot. The Mahogany Zone is about one-tenth of that of the leached zone. The The amount of water required for dust control and compaction of the overburden probably can be picked up from the overburden excavation, and this water would be fresh to slightly saline, which would permit other uses. If necessary, additional water slightly to very (saline) may be obtained from wells in the leached zone.

After sufficient overburden is removed to begin mining oil shale, additional water that will be required to mine, retort, and

refine shale at the rate in excess of that necessary to produce 100,000 bbl/day of shale oil, could be obtained from wells penetrating the leached zone. Fortunately, pumping water for consumption will lower the water level initially at a rate faster than the rate of increased depth of excavation. Depending on the real value of transmissivity, the storage coefficient, the effects of hydraulic boundaries, and on the consumptive use that will be determined by final plant efficiency, the amount of water available from wells and the altitude of the saturated zone can be either favorable or unfavorable to mining operations.

After a few years, the rate of withdrawal may need to be increased and water pumped to storage or treatment facilities in order to maintain a dry pit, if the transmissivity and storage coefficients are about the same or larger than have been estimated. Conversely, if aquifer characteristics are smaller than estimated, then yields may decline so that adequate ground water for consumptive use would not be available without drilling additional wells further from the pit and conveying the water to the site by pipeline. Chemical quality of the pumped water probably will deteriorate at some unknown rate as increasingly more saline water is obtained as the excavation increases in depth.

In the event that sufficient ground water is not available for the life of the lease, then surface water can be imported from either the White River or Colorado River by pipeline. The White River (about 18 miles from Tract C-a) is closer but would require the construction of reservoirs to assure a firm supply. Water is

available for purchase from the existing Green Mountain and Ruedi reservoirs and a possible future source of water is from the authorized West Divide Reclamation Project. A pipeline about 45 miles long would be required to convey water from these sources on the Colorado River.

e. Fauna

Tract C-a is inhabited on a seasonal or yearlong basis by a wide variety of wildlife species including mule deer, wild horses, mountain lion, coyote, bobcat, rabbits, hawks, golden eagle, sage grouse, and dove, plus numerous small bird and mammal species of aesthetic and ecological value. The area has very significant value for winter, as well as spring and fall deer range, and is used by possibly 10 to 20 wild horses.[1/]

Tract C-a, situated approximately 16 miles from a surfaced highway system on Piceance Creek, is served by a series of undeveloped roads and trails. The tract lies within a relatively remote and undisturbed habitat area managed by the Colorado Division of Wildlife for the primary benefit of wildlife species and a broad spectrum of recreational users. In addition, the Shields-Caldwall Hunting Camp, a private establishment headquartered within the tract boundaries, provides recreational access and services to members and guests annually. No angling habitat exists on the tract.

A large portion of the mule deer population utilizing high elevation summer range on the Cathedral Bluff-Roan Divide area to the south moves to historic winter range at lower elevation within

1/ For more detailed description of fauna of the Piceance Creek Basin, see Chapter II, Volume I.

the Piceance Creek Basin. Tract C-a lies within the intermediate winter range zone and bisects important deer migration routes used in their seasonal movements.

Numerous game-range studies conducted on mule deer populations confirmed that in range areas north of 36° N. latitude, major habitat limitations are found within winter-use zones. This winter range limitation appears to be particularly applicable to the White River and Roan Plateau herds. At 39.5° N. latitude, a line generally transecting the Piceance Creek Basin, the greater portion of range habitat suitable for mule deer winter use is found within the elevational zone ranging from 5,500 to 7,500 feet. Approximately 95 percent of the land area in the Piceance Creek Basin falls within this critical elevational range.

Existing land-use programs on Tract C-a involve the coordinated management of domestic livestock and wildlife resources on a continuing sustained-production basis. Some additional disturbance related to future oil, gas, or mineral development may be anticipated. However, in the absence of oil shale development it is assumed that current levels of wildlife productivity, species distribution, and recreational use can be maintained on a continuing and sustained-yield basis.

f. <u>Soils and Vegetation</u>

Tract C-a contains seven readily identifiable soils units, each having distinctive plant communities. The following sites occur as indicated as percentages of the total tract area, in percent:

Loamy slopes - 30

Pinyon-juniper woodland - 15

Rolling loam - 15

Rough broken land - 15

Deep loam - 10

Mountain swale - 10

Loamy breaks - 5

Each of these sites is described below.

(1) Loamy Slopes

(a) <u>Soils</u>: Moderately deep stone-filled, dark brown, sandy loam to light clay loam soils. The soil surface is also usually stony. Neutral to slightly alkaline reaction. Permeability is moderate; moisture holding capacity is reduced because of stoniness. Fertility level is moderate to fairly high.

(b) <u>Vegetation:</u> Dominant plants include big sage, serviceberry, dryland sedges, bluebunch wheatgrass, western wheatgrass. Indian ricegrass, balsam root, and a large variety of annual forbs, most of which are invaders. Ground cover is generally in the 25-30 percent range.

(c) <u>Physical Condition</u>: Occurs on north and east facing exposures scattered throughout the area. Topography is generally steep; erosion hazard is high. Present plant cover is near potential.

(2) Pinyon-Juniper Woodland:

(a) Soils: Very shallow to shallow soils, 0 to 20 inches, over shale and limy fine sandstone parent materials. Medium to moderately fine textured with a high silt content and varying amounts of rock and stones throughout. Runoff during intense rainstorms is typically heavy. Fertility levels are low to moderate.

(b) Vegetation: Dominant plants include pinyon pine, junipers, serviceberry, bitterbrush, Indian ricegrass, needle-and-thread grass, bluebunch wheatgrass and a variety of annual forbs. Ground cover in the 20-25 percent range.

(c) Physical Condition: Site is frail. Erosion is slight to moderate in higher elevations, moderate to severe in lower elevation. Plant cover is near potential.

(3) Rolling Loam:

(a) Soils: Generally deep, medium to moderately coarse texture. Dark grayish brown with weak to moderate subsoil development. These soils have good water holding capacity and take water moderately well, which make them favorable for plant growth. Fertility level is moderate.

(b) Vegetation: Open sagebrush stand with an abundant understory of grasses, principally western wheatgrass, needle-and-thread grass, and bluegrasses, and annual forbs. Ground cover ranges from 20-25 percent.

(c) Physical Condition: Located in lower elevations, subject to runoff from higher elevations, moderate to severe gully erosion, present plant cover is low compared to potential.

(4) Deep Loam:

(a) Soils: Moderately deep to deep dark brown sandy loam to lightly clay loam soils. Soil mixture, subsoil permeability, effective depth, and other soil factors are all favorable to plant growth and help create a productive site. Fertility levels are moderate to fairly high.

(b) Vegetation: Principal plants include big sagebrush, muttongrass, needle-and-thread grass, western wheatgrass, bluebunch wheatgrass, dryland sedges, and annual forbs, (principally hawksbeard, paintbrush, and hairy goldaster. Ground cover is about 30%.

(c) Physical Condition: Topography is rolling, erosion hazard is severe where vegetative cover is sparse. The area is subject to intensive summer thunder showers.

(5) Mountain Swale

(a) Soils: Weakly developed soils developing in loamy colluvial materials of varied origin. Runoff from adjacent uplands causes abundant grass growth that has built up a high organic matter content. Very favorable soil-water-plant relationships. Fertility levels are high.

(b) Vegetation: Vegetation is predominantly grasses such as basin wildrye, wheatgrasses, native bluegrasses and needlegrasses with a scattered stand of shrubs and forbs. Ground cover ranges from 35% to 45%.

(c) Physical Condition: Level areas in drainage ways. Sheet erosion is slight to moderate; gully erosion is severe in some locations. Present vegetative cover is much less than potential. Heavily grazed by wildlife and livestock.

(6) Loamy Breaks:

(a) Soils: Shallow, brown to gray brown medium textured loam or stony loam soil underlain by sandstone or shale. Permeability is moderate, but due to the steep slopes, the effective moisture is reduced. This is generally a droughty and unproductive site.

(b) Vegetation: Dominant plants include bitterbrush, big sagebrush, serviceberry, Indian ricegrass, and bluebunch wheatgrass. Ground cover is 20% to 25%.

(c) Physical Condition: In small scattered locations, mainly associated with pinon-juniper, slopes are short and steep; vegetation is fairly sparse.

(7) Rough Broken Land:

(a) Soils: These soils are very shallow, 0 to 10 inches, above parent materials of silty shales or lime fine sandstones. The soils are very erosive and active due largely to very steep slopes and very high runoff. Soil slipping is common and the steep slopes have a succession of short vertical exposures. Rock outcrops are common. Fertility is low.

(b) Vegetation: Vegetation is very sparse. Bitterbrush, serviceberry, currant, primrose, squirreltail, Indian ricegrass and wallflower are often predominant on north-facing slopes in this site. South-facing slopes are generally dominated by rabbitbrush, saltbush, horsebrush, phlox, and goldenweed.

(c) Physical condition: Very steep to vertical outcrops.

Plants occurring on the site are listed in Table II-8.

Table II-8. -Plants Occurring on Tracts C-a and C-b

Forbs

Scientific Name	Common Name	Site 1/
Achillea millefolium	Western yarrow	RL, MS, BL
Agastache urticifolia	Giant hyssop	BL
Agoseris glauca	Pale agoseris	MS
Allium spp.	Onion	RL
Amaranthus spp.	Amaranth	PJS, RL, MS
Androsace septentrionalis	Rockjasmine	PJS, RL, BL
Antennaria dimorpha	Pussytoes	LS, DL
Arabis spp.	Rockcress	BL
Artemisia ludoviciana	Herbaceous sage	LS, DL
Aster adscendens	Aster	PJW, RL, MS
Aster leucanthemifolius	Daisyleaf aster	PJW, RL, MS
Astragalus chamaeleuce	Loco	PJW, RL, DL, LB
Astragalus diversifolius	Timber poisonvetch	BL
Balsamorhiza sagittata	Arrowleaf balsamroot	LS, RL, DL, LB, BL
Brickellia grandiflora	Tasselflower brickellia	LS, DL, LB, BL
Calochortus gunnisonii	Gunnison mariposa	LS, DL, LB, BL, RL
Capsella bursa-pastoris	Shepherdspurse	PJW, BL, DL
Castilleja chromosa	Indian paintbrush	PJW, LS, DL
Chaenactis douglasii	Douglas chaenactis	PJW, LB
Chenopodium album	Lambsquarters goosefoot	DL, LS
Chorispora tenella	Purple mustard	PJW, LS, LB
Chrysopsis villosa	Hairy goldaster	PJW, LS, DL

Table II-8.- (continued)

Scientific Name	Common Name	Site [1/]
Cirsium spp.	Thistle	PJW, MS, BL
Clematis hirsutissima	Douglas clematis	PJW, MS, BL
Cleome serrulata	Bee spiderflower	PJW, MS, BL
Corydalis aurea	Golden corydalis	PJW, MS, BL
Crepis spp.	Hawksbeard	DL
Cryptantha spp.	Cryptantha	PJW
Delphinium nelsoni	Menzies larkspur	LS, DL, BL
Descurainia pinnata	Pinnate tansymustard	LS, DL, BL
Erigeron pulcherrimus	Fleabane	RL, DL, MS, BL, RBL
Eriogonum alatum	Wing eriogonum	PJW, LS, RL, DL, LB, BL
Eriogonum tristichum	Eriogonum	PJW, LS, RL, DL, LB, BL
Eriogonum umbellatum	Sulfur eriogonum	PJW, LS, RL, DL, LB, BL
Erysimum asperum	Wallflower	RBL
Galium boreale	Northern bedstraw	BL
Geranium caespitosum	Geranium	MS, BL
Gilia aggregata	Skyrocket gilia	PJW, DL, LB
Haploppapus acaulis	Stemless goldenweed	PJW, DL, RBL
Hedeoma drummondii	Drummond falsepennyroyal	PJW, LS, DL
Hedysarum pabulare	Northern sweetvetch	LS
Helianthus spp.	Sunflower	LS
Heracleum lanatum	Cow parsnip	BL
Heuchera parvifolia	Alum root	LB
Hymenoxys acaulis	Stemless actinea	LB, LS
Juncus spp.	Rushes	MS

Table II-8.- (continued)

Scientific Name	Common Name	Site [1/]
Lactuca pulchella	Chicory lettuce	MS, LS
Lappula redowskii	Stickseed	MS
Lathyrus leucanthus	Aspen peavine	BL
Lepidium montanum	Mesa pepperweed	LS, LB
Lesquerella spp.	Bladderpod	PJW
Leucelene ericoides	Heath aster	MS
Linium lewisii	Lewis flax	DL, LS
Lithospermum ruderale	Wayside gromwell	LS, DL
Lupinus greenei	Tailcup lupine	PJW, RL, DL, LB,BL
Mamillaria missouriensis	Pincushion cactus	PJW, RBL, LB
Mertensia spp.	Bluebells	RL, DL, BL
Muhlenbergia montana	Mountain muhly	BL
Oenothera serrulata	Evening primrose	LS, DL, LB
Oenothera caespitosa	Tufted primrose	BL
Opuntia spp.	Prickly pear cactus	PJW, RL, DL
Oxytropis lambertii	Lambert's crazyweed	DL, LS
Penstemon caespitosa	Mat penstemon	PJW, DL, BL, RBL
Penstemon fremontii	Fremont penstemon	LS, DL, BL
Perideridia gairdneri	Yampa	BL
Phlox caespitosa	Low phlox	PJW, RL, DL, RBL
Phlox hoodii	Hood's phlox	PJW, RL, DL, RBL, LS
Phlox longifolia	Longleaf phlox	PJW, RL, DL, RBL, LS
Physaria australis	Common twinpod	LB, PJW, DL
Polanisia trachysperma	Roughseed clammyweed	LB, PJW, LS

Table II-8.- (continued)

Scientific name	Common Name	Site [1/]
Polemonium foliosissimum	Leafy polemonium	BL
Polygonum spp.	Knotweed	BL
Potentilla gracilis	Herbaceous cinquefoil	MS, BL
Salsola kali	Russian thistle	PJW, LB, RBL, MS
Senecio multilobatus	Lobeleaf groundsel	LS, DL, PJW, RBL
Senecio spp.	Groundsel	LS, DL, PJW, RBL
Senecio mutabilis	Groundsel	LS, DL, PJW, RBL
Sideranthus spp.	Gumweed	MS
Schoenocrambe linifolia	Flaxleaf plain mustard	MS
Sisymbrium altissimum	Tumblemustard	PJW, LB, DL, LS
Sisymbrium officinalis	Tumblemustard	PJW, LB, DL, LS
Solidago spp.	Goldenrod	PJW
Sphaeralcea coccinia	Scarlet globemallow	PJW, LS, RL, DL
Taraxacum officinale	Common dandelion	MS
Thermopsis montana	Rocky Mountain golden pea	BL
Tragopogon porrifolius	Vegetable-oyster salsify	MS, DL
Tragopogon pratensis	Meadow salsify	MS, DL
Trifolium gymnocarpum	Holly leaf clover	DL
Urtica dioica	Bigsting nettle	MS
Vicia americana	American vetch	RL, BL
Wyethia amplexicaulis	Wyethia	BL
Zygadenus gramineous	Death camas	RL

Table II-8.-(continued)

Grasses and Sedges

Scientific Name	Common Name	Site 1/
Agropyron albicans	Montana wheatgrass	LS,LB
Agropyron inerme	Beardless bluebunch wheatgrass	PJW, LS, RL, DL, LB, RBL
Agropyron smithii	Western wheatgrass	PJW, LS, RL, DL, MS, LB, BL
Agropyron subsecundum	Bearded wheatgrass	MS
Agropyron trachycaulum	Slender wheatgrass	MS, BL
Aristida spp.	Three awn	PJW
Bouteloua gracilis	Blue grama	PJW, LS
Bromus anomolus	Nodding brome	MS, BL
Bromus tectorum	Cheatgrass	PJW, LS, DL
Carex geyeri	Elk sedge	PJW, LS, MS, BL, DL,BL
Carex nebraskensis	Nebraska sedge	PJW, LS, MS, BL, DL,BL
Carex eleocharis	Needleleaf sedge	PJW, LS, MS, BL, DL,BL
Elymus condensatus	Giant wildrye	PJW, LS, MS, BL, DL,BL
Elymus cinereus	Basin wildrye	PJW, LS, MS, BL, DL,BL
Elymus salinus	Salina wildrye	PJW, LS, MS, BL, DL,BL
Festuca idahoensis	Idaho fescue	BL
Hilaria jamesii	Galleta	PJW
Koeleria cristata	Prairie junegrass	PJW, LS, RL, DL, LB,BL
Melica bulbosa	Onion grass	BL
Oryzopsis hymenoides	Indian ricegrass	PJW, RL, DL, LB, RBL
Oryzopsis micrantha	Littleseed ricegrass	PJW, LS, BL

Table II-8.-(continued)

Shrubs and Half-Shrubs

Scientific Name	Common Name	Site 1/
Amelanchier utahensis	Utah serviceberry	PJW, LS, RL, DL, MS LB, BL, RBL
Artemisia cana	Silver sage	BL
Artemisia dracunculoides	Wormwood	LB, BL
Artemisia frigida	Fringed sagebrush	PPW, LS, RL, DL, MS, LB, BL, RBL
Artemisia nova	Black sagebrush	LB, BL
Artemisia tridentata	Big sagebrush	PJW, LS, RL, DL, MS, LB, BL
Atriplex canescens	Four-wing saltbush	PJW, RBL
Cercocarpus montanus	Mountain mahogany	PJW, LS, BL
Chrysothamnus depressus	Dwarf rabbitbrush	PJW, LS, RL, DL, MS, BL, RBL
Chrysothamnus nauseosus	Rubber rabbitbrush	PJW, LS, RL, DL, MS, BL, RBL
Chrysothamnus viscidiflorus	Low rabbitbrush	PJW, LS, RL, DL, MS, BL, RBL
Ephedra spp.	Jointfir	PJW, LS
Eurotia lanata	Winterfat	PJW, RBL
Gutierrezia sarothrae	Broom snakeweed	PJW, RL, DL, LB
Leptodactylon pungens	Gilia	DL
Prunus virginiana	Chokecherry	MS
Purshia tridentata	Antelope bitterbrush	PJW, LS, LB, BL, RBL
Quercus gambelii	Gambel oak	LS, DL, BL

Table II-8.- (continued)

Scientific Name	Common Name	Site 1/
Poa ampla	Big bluegrass	DL, BL, RBL, LS, MS
Poa canbyi	Canby bluegrass	DL, BL, RBL, LS, MS
Poa pratensis	Kentucky bluegrass	DL, BL, RBL, LS, MS
Poa secunda	Sandberg bluegrass	DL, BL, RBL, LS, MS, PJW, RL, LB
Sitanion hystrix	Bottlebrush squirreltail	PJW, LS, RL, DL, LB, BL, RBL
Sporololus cryptandrus	Sand dropseed	PJW, LS, DL
Stipa comata	Needle and thread	PJW, LS, RL, LB, RBL, DL, BL
Stipa lettermani	Letterman needlegrass	PJW, LS, RL, LB, RBL, DL, BL
Stipa robusta	Sleepy grass	PJW, LS, RL, LB, RBL, DL, BL
Stipa viridula	Green needlegrass	PJW, LS, RL, LB, RBL, DL, BL

Table II-8.- (continued)

Scientific Name	*Common Name*	*Site* 1/
Rhus trilobata	Shrubs and half-shrubs	PJW, RBL
Ribes spp.	Currant	LBL
Rosa spp.	Rose	MS, BL
Sarcobatus vermiculatus	Greasewood	MS
Symphoricarpos tetonensis	Snowberry	PJW, LS, DL, MS, BL
Tetradymia canescens	Gray horsebrush	LS, RL, LB, RBL
Yucca spp.	Yucca	LB, LS
	Trees	
Juniperus osteosperma	Utah juniper	PJW, LS, RL, DL, RBL
Juniperus scopueorum	Rocky Mountain juniper	PJW
Pinus edulis	Pinyon pine	PJW, LS, RL, DL, RBL
Salix spp.	Willow	MS

1/ The abbreviations listed under this column are:

LS - Loamy slopes
PJW - Pinyon juniper woodland
RL - Rolling loam
RBL - Rough broken land
DL - Deep loam
MS - Mountain swale
LB - Loamy breaks

g. Grazing

Tract C-a is included in two separate grazing allotments that are utilized by 1,200 head of cattle during the spring and fall months; the grazing periods total about 5 months. Approximately 600 animal unit months (AUM) of this grazing use is on the tract. The present use rate is about 8.5 acres/AUM [1/]. In addition, an estimated 120 AUM of grazing use is made on the tract by the 150-250 wild horses in the Piceance Creek Basin.

Livestock water facilities and fences located on and adjacent to the tract provide for grazing distribution and livestock control. Continued grazing of undeveloped portions of the tract and surrounding areas will require maintenance or replacement of these facilities. The tract and waste disposal areas extend across normal livestock travel routes from lower to higher elevation range areas.

The tract area has potential for increases in livestock forage production through management systems and/or vegetative manipulation. Management systems involve periods of grazing and periods of protection (non-grazing) in accordance with physiological requirements of key plant species. Vegetative manipulation involves mechanical or chemical treatment to eliminate or reduce certain plant species and thereby make a greater portion of the available moisture, plant nutrients and sunlight available for the remaining plants. The increase potential is estimated to be in the range of 20 percent to 40 percent through management systems and 50 percent to 100 percent through vegetative manipulation.

1/ One animal unit month (AUM) is the amount of forage required to keep one cow and one calf for 1 month.

Invasion of disturbed areas by poisonous plants has not been considered a serious problem in the Piceance Creek drainage. However, rabbitbrush, an undersirable species from a livestock grazing standpoint, has a tendency to invade and virtually exclude other species on disturbed areas on alluvium soils in drainage bottoms.

h. Esthetics

Tract C-a is located in an area subject to few disruptive noises and offers unobstructed views of the surroundings. The air is clear, and visibility is limited only by natural land forms and horizon. Visibility ranges of 100 miles or more are common.

The main roads are in drainage bottoms and are not visible in general views of the area. Other works of man are limited and obstruct the view only in limited areas.

Noises associated with man's activities, which can be heard short distances from the point of origin, are limited to scattered drilling rigs exploring for oil or gas or coring the oil shale, and intermittent discharges of firearms.

Cathedral Bluffs, west of the tract, are an unusual land form. They are nearly vertical rock cliffs several hundred feet in height. They are visible for several miles from the north and west, as well as from certain locations on the highway from Rangely to Grand Junction. The bluffs are generally considered a scenic area because of their gray color and unique form.

i. Recreation

Tract C-a and the surrounding area have a sizeable mule deer population. The fall deer hunt is a major recreation activity there.

A local hunting club, having surface patents rights, utilizes four small buildings in the tract as a hunting camp during the big game hunting season.

j. Archeological and Historical Values

Tract C-a does not include any known points of historic interest on sites of archeological discovery.

k. Socio economic Status

With the exception of a private hunting camp and a few unimproved dirt roads, Tract C-a has no existing economic or social development.

l. Possible Off-site Solid Waste Disposal Areas for Tract C-a

(1) Overburden - The valley of Water Gulch provides an easily accessible disposal area for overburden from a surface mining operation on Tract C-a (See Figure IV-4 and related discussion). The gulch is a 4-mile long east flowing tributary of Corral Gulch that has a small permanent flow of water (less than 0.5 cfs) throughout much of its length. The average relief from valley floor to ridge crest is 400 feet. The drainage of Water Gulch encompasses an area of about 5 square miles and of this approximately 2 square miles is in the headwaters above the proposed waste disposal site. Water Gulch heads at an elevation of 8,600 feet and empties into Corral Gulch at an elevation of 7,000 feet. The gradient for the entire length of the creek averages 400 feet per mile; however, for that part of the creek being considered for waste disposal, the gradient is only 200 feet per mile.

The existing environments of the possible overburden disposal site is essentially the same as that for Tract C-a described above.

The proposed overburden disposal area is covered by pre-1920 oil shale claims and by post-1920 placer claims involved in contest 441, now pending on appeal to the Interior Board of Land Appeals. If the claims are valid, the lands will be in private ownership and the Federal Government will be unable to dictate their use, without protection of the private interests.

(2) Spent Shale Disposal Area - The middle and lower reaches of the steep walled gullies draining west from Big Ridge or the Cathedral Bluffs to Douglas Creek provide possible spent shale disposal sites (Figure IV-2 and related discussion). The gullies consist of a series of relatively straight subparallel drainages that have an area of approximately 6 square miles, of which about 3.5 square miles is in the area of the headwaters above the proposed solid waste disposal area. Philadelphia Gulch heads at an elevation of about 8,200 feet along the crest line of the Cathedral Bluffs and empties into Douglas Creek at an elevation of about 5,800 feet. Although this gradient averages 520 feet per mile for the entire length of the creek, that part designated as a potential spent shale disposal site has an average gradient of only 140 feet per mile.

All of the valleys being considered for solid waste disposal in the Douglas Creek area are occupied by intermittent streams that carry water only during periods of rapid snow melt or heavy rainfall. The valley floors are covered with alluvium, 20 or more feet thick, that is deeply incised. During periods of heavy runoff, these tributaries to Douglas Creek, and Douglas Creek itself, which is also deeply incised, transmit large quantities of water and silt into the White River.

The Mesa Verde, Wasatch, and the lower part of the Green River formation underlie the area and are exposed along the valley walls. The rocks consist mainly of sandstone, siltstone, shale, and mudstone with minor amounts of coal beds and fresh water limestones. The thicker beds of coal are in the lower part of the Mesa Verde formation that crops out in, and adjacent to, the valley of Douglas Creek. Many of the coal beds have been burned in extensive areas above the outcrop. Probably because of the large burns, thin nature and relatively poor quality of the coal beds and long distance from a market, the coal in this area has not been mined. Oil and gas have been encountered in the Wasatch, Mesa Verde, and underlying formations in the Douglas Creek area. However, no oil or gas have been produced within several miles of the area proposed for solid waste disposal.

Soil in the area consist of shallow and moderately deep cobbly, stony, and shaly soils and moderately deep wind-laid soils designated as types 6 and 12 on Figure II-18, page II-32, and described in detail in Section B of this Chapter.

Most of the south-facing slopes in the area are barren of vegetation. However, the ridge tops and north-facing slopes, and in a few places the south-facing slopes, sustain a growth of pinyon-juniper, mountain mahogany, some sage, and serviceberry. Vegetative cover in the valley bottoms consists of rabbitbrush, greasewood, cheatgrass, western wheatgrass, and some Indian rice grass. Air photos covering the general areas are Soil Conservation Service photo ALJ 1861 taken in 1937 and U.S.G.S. photo GSVAQD 1-162 taken in 1963.

This area functions primarily as winter range for deer. Generally, the other species associated with the area are predators, raptors, and small mammals. No nesting sites for raptors have been identified.

The potential solid waste disposal area is all public domain lands withdrawn as potentially valuable for coal by Executive Order dated July 6, 1910. Some post-1920 claims in T. 1 S., R. 101 W., are being contested by the Government in Contest 441, now pending before the Department of the Interior Board of Land Appeals.

Should this area actually be selected as a disposal area, the Executive Order may need to be modified. The coal located within this particular area consists of thin seams that are not of economic value.

2. Colorado Tract C-b (Piceance Creek Basin)

a. Physiography

Tract C-b is located in the central part of the Piceance Creek Basin, a short distance southwest of Piceance Creek. The topography (Fig. II-3) is characterized by narrow, steep-walled valleys and broad rounded ridges. The general topographic form is that of a northward sloping plateau that has been dissected by north flowing streams draining into Piceance Creek. Altitudes in the tract range from about 6,400 feet in the northeast corner on Stewart Gulch to about 7,100 feet on a ridge in the south central part. Greatest relief between valley floor and nearby ridge top is about 400 feet. Photographs of the area are shown in Figures II-25 and II-26.

Figure II-25.-Ground view Site C-b, Colorado, showing characteristic valley land form and vegetation (Standard Draw).

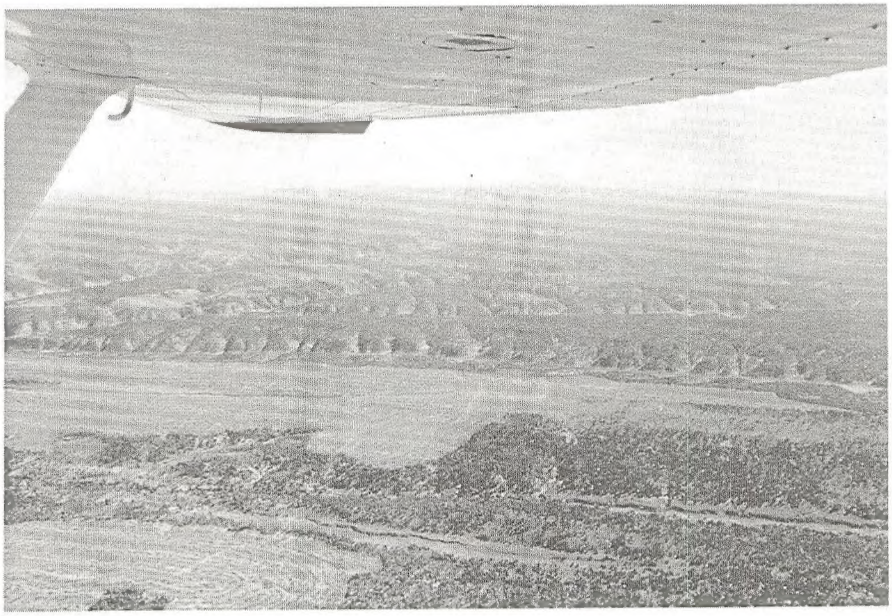


Figure II-26.-Oblique aerial view, Site C-b, Colorado, looking eastward across the tract.

b. Climate

Tract C-b is classified as semiarid in climate with annual average precipitation amounts ranging from about 10 inches to a maximum of 18 inches, depending on altitude. The total number of days with precipitation amounts greater than .10 inch is about 40. Approximately half of the annual precipitation occurs as snow. Accumulated snow depth on higher terrain may exceed 3 feet for short time periods. Precipitation during the warmer months occurs mainly with local thunderstorms which are more frequent over higher terrain. Thunderstorms are often severe with strong local gusty winds and high precipitation rates causing local flash flooding.

The mean maximum temperature in January is about 38°F and the mean minimum about 5°F. The highest recorded in January is 60°F and the lowest is -35°F. The mean maximum temperature in July is about 86°F and the mean minimum about 45°F. The highest recorded in July is 98°F and the lowest is 30°F. The frost free period is approximately 90 days.

Prevailing winds are from a southwesterly direction, but gusty winds may occur from other directions depending on large-scale atmospheric circulation. Local topographic features have a strong influence on wind flow and create well organized mountain and valley wind flow patterns (Volume I, Chapter II). In all seasons, when local flow regimes predominate, the most frequent wind direction is from the northwest (upslope) during the warmer part of the day;

and the most frequent direction during the colder part of the day is from the southwest.

Night temperature inversions occur frequently over the Piceance Creek Basin in the lower few hundred meters above the terrain because of strong radiation cooling in the rather dry atmosphere.

c. Geology and Mineral Resources

Tract C-b is located in the geologic settin described in Section II of Volume I of this Environmental Statement. The beds in Tract C-b (Fig. II-27) strike to the east or northeast in most of the tract. The axis of a syncline is subparallel to the northern boundary of the tract, and north of the axis the strike of the rocks is to the northwest. Dip in most of the area is north to northwest at the rate of 150 feet per mile. Along the northern boundary the dip is southwest at the rate of 200 feet per mile.

Oil-shale value, as shown by assays from core in nearby holes, increases in a northerly direction. The Mahogany Zone contains about 140 feet of shale that averages 30 gallons of oil per ton and the lower zone possibly contains an additional 210 feet of shale averaging 30 gallons of oil per ton with a total in-place resource of about 700,000 barrels per acre. Overburden on the Mahogany Zone varies from a minimum of 800 feet to a maximum of 1,250 feet and averages 1,100 feet. The shale oil resource recoverable from the tract by

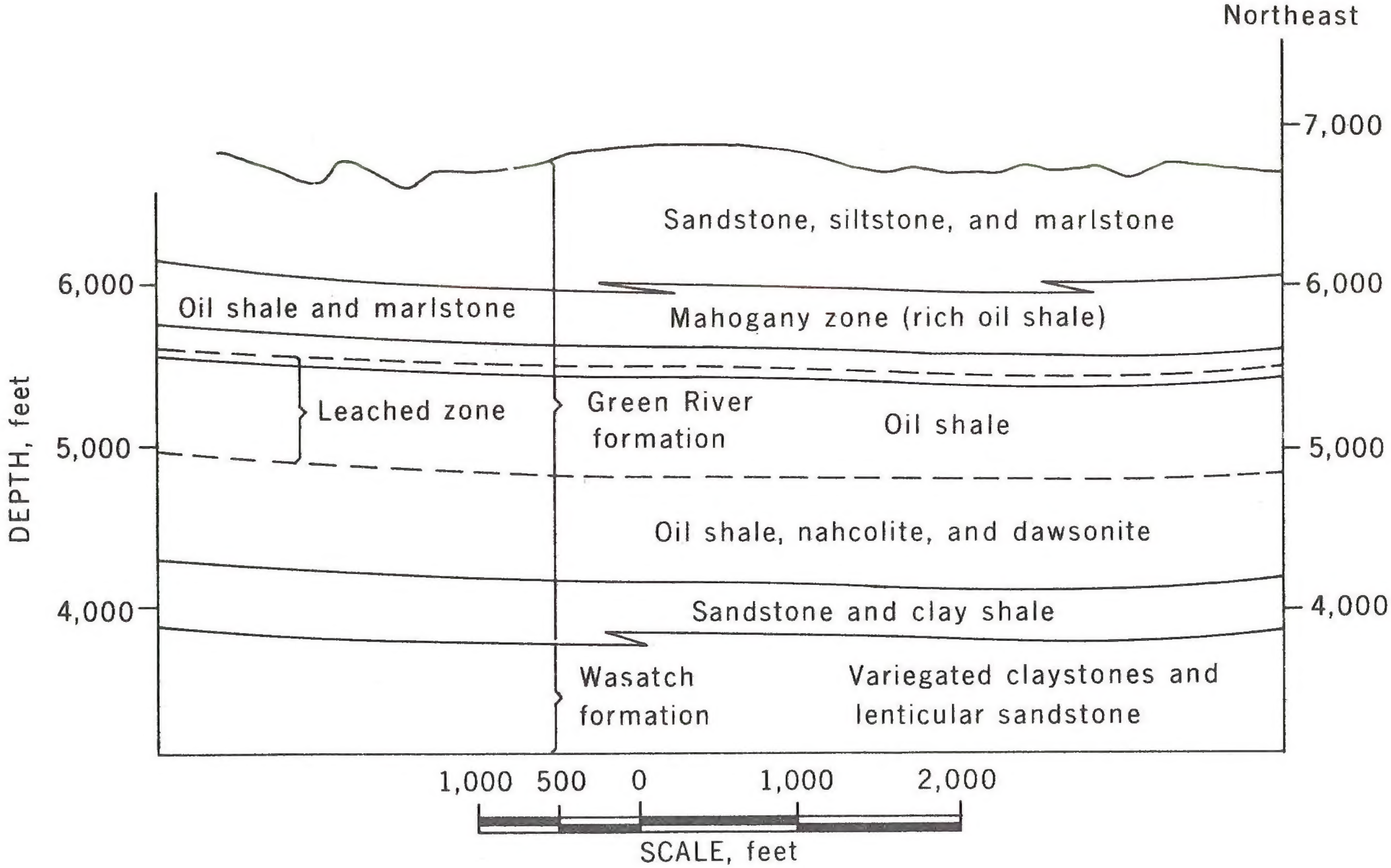


Figure II-27.-Generalized Cross Section for Tract C-b, Colorado.

underground mining methods is estimated to be 723,000,000 barrels. Nahcolite is present in pods in the lower part of the lower zone and may be bedded in the northwest part of the tract. Oil shale containing dawsonite in varying amounts may attain a thickness of 300 feet in parts of the area. No oil or gas has been found in Tract C-b; however, commercially significant amounts of gas and small amounts of oil have been produced from the Douglas Creek Member of the Green River formation, and the Wasatch, Fort Union, and Mesa Verde formations elsewhere in the Piceance Creek Basin. The Fort Union and Mesa Verde formations being considered in the Rio Blanco gas stimulation proposal underlie the entire tract at a depth of 2,000 or more feet below the base of the oil shale.

d. Water Resources

Tract C-b is drained by tributaries of Piceance Creek. The tributaries carry water only during periods of snow melt or following heavy rain or thundershowers. Piceance Creek is less than a mile north of the northeast corner of the tract. Fresh water is present in the alluvium along Piceance Creek and the larger tributary valleys. However, prior water rights and Colorado water law would limit development and use of alluvial ground water or the water from Piceance Creek. Well locations and the attitude of the water table in the vicinity of Tract C-b are shown in Figure II-28.

Data from test wells on and near Tract C-b indicate that the transmissivity of the upper zone (land surface to base of Mahogany) is about 5,000 gallons per day per foot and the transmissivity of the underlying leached zone ranges from about 1,500-6,000 gallons per day per foot.

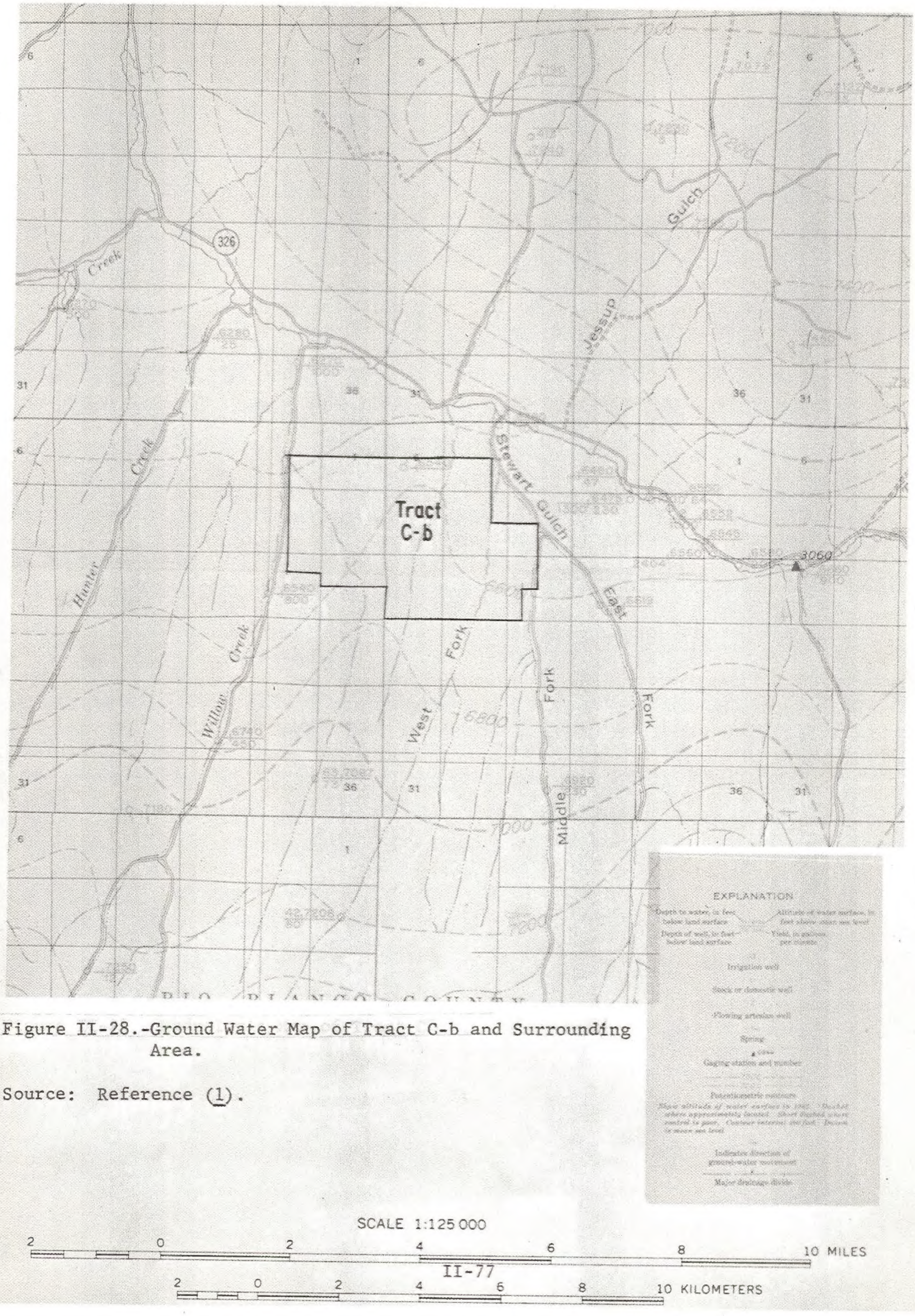


Figure II-28.-Ground Water Map of Tract C-b and Surrounding Area.

Source: Reference (1).

Core test wells drilled by the air-rotary method yielded from 200 to 600 gpm during drilling. Dewatering wells would initially yield much larger amounts. The depth to water in the upper zone ranges from about 70 to 340 feet beneath the ridges and the water level is essentially at land surface beneath the lower valley floors. Flowing wells can be expected in valleys on or near the north end of the tract. The potentiometric surface slopes about 50 to 100 feet per mile to the north and northwest beneath the tract. The difference in head between the upper and lower zones is as much as 60 feet in parts of the tract.

The specific conductance of water in the upper zone ranges from 800 micromhos or less to 2,000 micromhos. The conductance of water in the lower zone is probably as high as 20,000 micromhos.

The CER Geonuclear Corporation drilled two holes at the proposed Project Rio Blanco site (a proposed nuclear gas stimulation project), about 6 miles west of the Western Margin of Tract C-b. Data on water discharge during drilling of hole RB-D-01 with air as the circulating medium are shown graphically in Figure II-29. The data shows that the discharge was a little less than 100 gpm when the hole was 425 feet deep and the discharge of 700 gpm was measured by the time the hole was a little more than a thousand feet deep. Additional data on this hole are presented in Volume I, Chapter II.

If it is necessary to lower the water level below the underground mine workings, more ground water would be pumped initially than would be consumed in spent shale disposal, retorting, and other operations attendant to the production of 50,000 bbl/day of

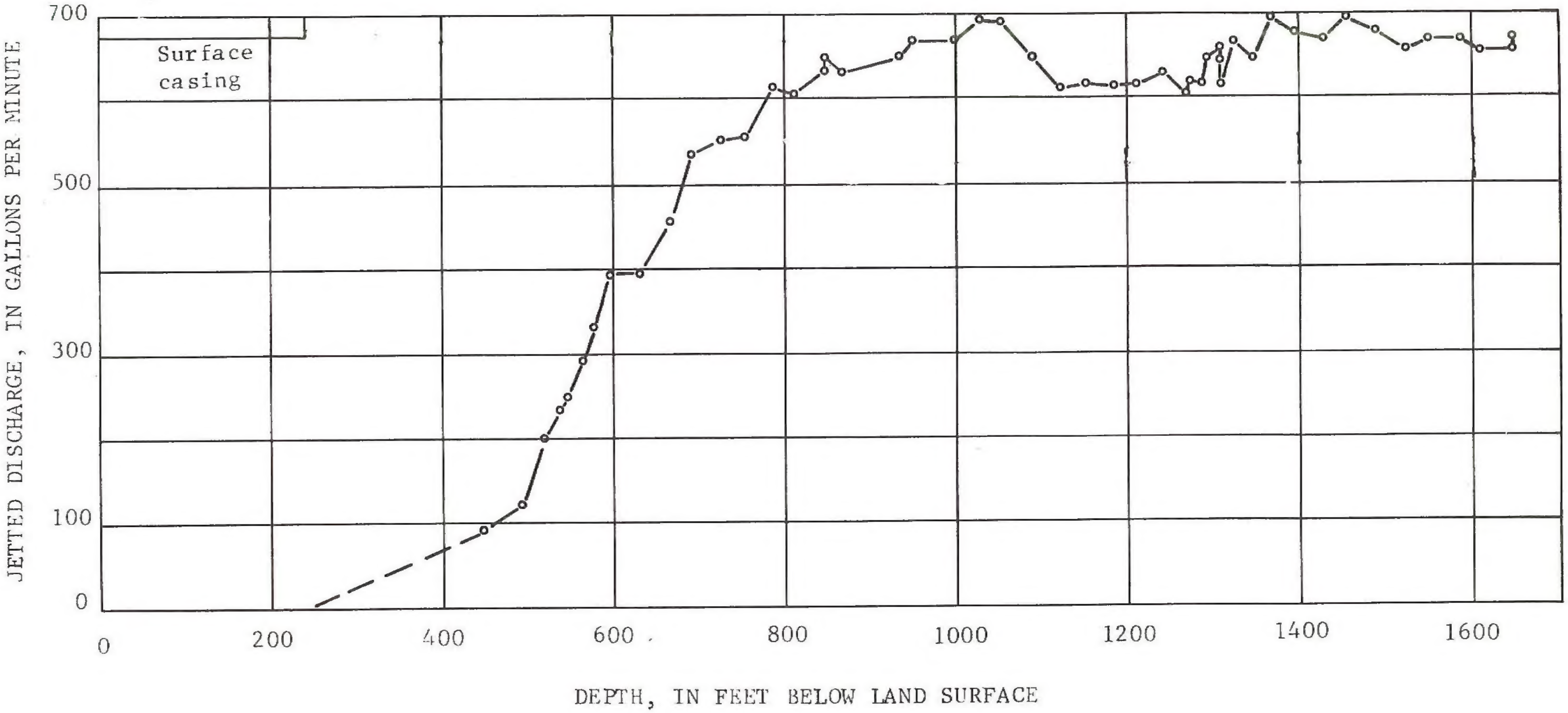


Figure II-29.-Graph of jetted discharge during drilling of hole RB-D-01, Project Rio Blanco, Colorado.

Source: Reference (2).

shale oil. Maintaining a water level beneath the mine workings could result in water being pumped to waste during the early years of mining, but the yield would decrease to less than consumptive use before the mine was worked out. The dissolved solids content of the ground water would cause the water to be usable to marginal for some purposes initially, but the pumped water would deteriorate with time as water having a higher dissolved solids content moved into the cone of depression. The quality of water would be suitable for many of the larger consumptive uses such as spent shale disposal.

After the yield of the mine declines to less than consumptive use, additional ground water can be obtained by drilling more wells further from the mine or surface water can be obtained from the White River or Colorado River. Tract C-b is about 25 miles from the White River by way of the Piceance Creek Valley and is about 30 miles from the Colorado River at the mouth of Parachute Creek. A firm supply of water from the White River would require construction of an upstream dam and reservoir, as well as conveyance from the river to the tract. Water is available for purchase from existing reservoirs on upstream tributaries of the Colorado River. The quality of water from both rivers is good.

e. Fauna

Tract C-b is inhabited on a seasonal or year long basis by a diverse association of wildlife species including mule deer, elk, mountain lion, coyote, bobcat, rabbits, sage grouse, dove, golden eagle, and several hawks, as well as numerous small bird and mammal

species. This tract with a mean elevation of approximately 6,800 feet, receives some intermittent use by wintering herds of deer.[1/]

Tract C-b lies immediately adjacent to a heavily used surfaced highway on Piceance Creek, and unimproved roads which parallel West Stewart and Scandard Gulches. As a result, the tract is currently subject to the disruptive impact of moderate traffic flows, as well as the effects of intensive livestock operations conducted on several large ranches, which have nearby headquarters in the Piceance Creek Valley. Although large portions of the tract contain significant wildlife resource values, game harvest and general recreational use is relatively limited through current actions of controlling landowners. Recreation-oriented activities, primarily sport hunting, account for several hundred man-days use per year. No angling habitat exists on the tract.

Current land-use objectives related to Tract C-b acreage involve domestic livestock garzing as well as optimum production of indigenous wildlife species. Populations of a number of birds and mammals designated as game species, as well as various carnivores, are managed on a sustained-yield basis, consistent with food and other habitat requirements. Without oil shale development, or other development that would impact the area, it is anticipated that currently existing associations of wildlife species and their productivity could be maintained on a continuing, sustained basis for the foreseeable future.

1/ For a more detailed description of the fauna of the Piceance Creek Basin, see Chapter II, Volume I.

f. Soils and Vegetation

Tract C-b contains eight readily identifiable soil units, each having distinctive plant communities. The following soils occur as indicated as percentages of the total tract area in percent:

Pinyon-Juniper Woodland - 25

Loamy Slopes - 25

Rough Broken Land - 20

Rolling Loam - 10

Deep Loam - 5

Mountain Swale - 5

Loamy Breaks - 5

Brushy Loam - 5

The site descriptions provided for Tract C-a, except Brushy Loam, apply to Tract C-b. The Brushy Loam site is described below.

(1) Brushy Loam:

(a) Soils: Dark brown to very dark brown sandy loam to light clay loam acid top soil 10 to 20 inches thick. The subsoil is a moderately strongly structured clay loam to light clay 1 to 4 feet thick and is moderately permeable. There may be a number of stones or cobbles throughout the profile. The soil is very favorable to plant growth. Fertility is high.

(b) Vegetation: Serviceberry is the dominant appearing plant with a large number of grasses, forbs, and other shrub species. Ground cover is generally in the 50 to 60 percent range.

(c) Physical Condition: Generally located on steep, north facing slopes. Erosion is slight to moderate. Brush species generally in thick stands.

Important plants occurring on Tract C-b are listed in List II-1. Characteristic vegetation of the area is shown in Figures II-18 and II-19.

g. Grazing

Tract C-b is included in a grazing allotment utilized by 7,781 cattle under five separate grazing permits. Grazing is generally confined to spring and fall periods totaling about 5 months. Approximately 650 AUM of this grazing use is on the tract. The present use rate is about 7.9 acres/AUM.

All information on grazing presented for Tract C-a except present use as noted in the preceding paragraph applies to Tract C-b.

h. Esthetics

Tract C-b is in an area subjected to few disruptive noises and offers unobstructed views of the surroundings. The air is clean and visibility is limited only by natural land forms and the horizon.

The main roads are in drainage bottoms and are not visible in general views of the area. Other works of man are limited and obstruct the view only in limited areas.

Other impacts are related to noise associated with man's activities. These activities that can be heard at a distance from the point of origin include discharging firearms, noise from vehicles, and noise from scattered drilling rigs exploring for oil or gas or coring into the oil shale.

i. Recreation

Tract C-b and the surrounding area have a sizeable mule deer population. The fall deer hunt is the primary recreation activity in the tract.

j. Archeological and Historical Values

Tract C-b does not include any known points of historic interest or sites of archeological discovery.

k. Socioeconomic Status

With the exception of a few unimproved dirt roads, Tract C-b has no existing economic or social development.

l. Possible Off-site Solid Waste Disposal Area for Tract C-b

A possible solid waste disposal area for Tract C-b (Fig. IV-6) is near the mouth of Stewart Gulch in the drainages of the east, middle, and west forks of Stewart Gulch. Approximately one-third of the disposal area is on the tract in the West and Middle Forks of Stewart Gulch and the remainder of the disposal would be in close proximity to the tract.

Each of the forks of Stewart Gulch is approximately 10 miles in length and at least in places contains a permanent flow of water. The Middle Fork has a small flow of permanent water (maximum of about 0.7 cfs) throughout much of its length. Average relief from valley floor to ridge top in the disposal area is 500 feet. Each of the forks has a number of tributaries several miles in length that form the headwaters drainage area. Of the three forks of Stewart, the middle fork has the largest drainage area, approximately 24 square miles; the east fork drainage area encompasses

about 18 square miles and the west fork about 16 square miles. Eighty to 90 percent of the drainage area of the forks of Stewart Gulch is upstream from the waste disposal. The forks of Stewart Gulch head at the crest of the Roan Plateau at an elevation of about 8,300 feet, and Stewart Gulch joins Piceance Creek at an elevation of about 6,400 feet. The gradient for the entire drainage averages 190 feet per mile; however, the gradient of that part of the drainage being considered is only about 110 feet per mile.

The existing environment of the possible solid waste disposal site is essentially the same as that for Tract C-b described above.

The area considered for solid waste disposal has mixed ownership. The following legal subdivisions are patented, with no minerals reserved, only ditches and canals reserved, SW¼SW, sec. 4; E½SE¼, sec. 5; NW¼NW¼ and W¼SW¼, sec. 9; W½NE¼, sec. 16, E½SW¼ and the SW¼SW¼, sec. 20, all in T. 3 S., R. 96 W. In the following legal subdivisions the surface is patented, oil and gas and oil shale or other rock valuable as a source of petroleum and nitrogen is reserved to the United States, E½NE¼, sec. 8, S½NW¼, sec. 9, SE¼NW¼ and the NE¼SW¼, sec. 15, E¼SW¼, sec. 16, and SE¼NW¼, sec. 20, all in T. 3 S., R. 97 W. The remainder of the land on the disposal site is unpatented and does not have any pre-1920 oil shale claims; however, much of the total waste disposal area is covered by post-1920 placer claims involved in Contest 441, now pending on appeal to the IBLA. If the claims are valid, the lands will be in private ownership and the Federal Government will be unable to dictate their use, without protection of the private interests.

3. Utah Tracts U-a and U-b (Uinta Basin)

a. Physiography

Tract U-a is immediately south of the White River in the eastern part of the Uinta Basin. The valley of the White River occupies a narrow strip about 800 feet wide in the north-central part of the tract(Figure II-6). Southam Canyon, a slightly meandering drainage, extends northwestward across the tract and joins the White River just outside the tract. Numerous minor drainages in the tract are tributary to Southam Canyon and to White River, the only perennial stream. The topography (See Figures II-9 and II-12) is characterized by high, sinuous ridges bounded by cliffs and separated by lower areas of narrow branching ridges and stream valleys. Innumerable small buttes are spaced randomly along the drainage divides. Altitudes within the tracts range from about 4,900 feet on the White River to about 5,960 feet in the south-central part. Greatest altitude difference in a short distance is about 450 feet in one-half mile in the south-central part of the tract.

Tract U-b is located immediately south of the White River in the eastern part of the Uinta Basin. The White River is an all year stream and is about 1 mile from the northwestern corner of the tract. The canyon of Evacuation Creek trends northward across the central part of the tract. East of Evacuation Creek the topography is characterized by rounded forked ridges with scattered ledges and cliffs. West of Evacuation Creek the terrain is more rugged and is characterized by ledges and cliffs along the canyon walls and numerous buttes along the drainage divides (See Figures II-30 and

Figure II-30 A view of the central portion of Tract U-a from the N½ of Sec. 28, T. 10 S., R. 24 E.

Figure II-31 A view looking west across Evacuation Creek from Sec. 13, T. 10 S., R. 24 E., of the NW portion of Tract U-b.

II-31. Altitudes range from 4,950 feet along the White River to about 5,850 feet near the southwest corner. Greatest altitude difference in a short distance is about 300 feet in one-half mile in the southwestern part of the tract.

b. Climate

The climate of both tracts U-a and U-b is semiarid with annual precipitation amounts ranging from about 8 inches at lower elevations to 10 inches over higher terrain. Near the site about 10 inches of precipitation occur per year with about 4 inches from May to September mostly from thunderstorms and 6 inches from October to April.

Approximately 25 days per year have precipitation amounts in excess of .01 inch. Severe local, summer thunderstorms may cause strong gusty winds and local flash flooding. The average annual snow accumulation is about 10 inches. Open areas may remain free of snow for most of the winter.

The area has dry hot summers with an average July maximum temperature of 95° F. and an extreme of 105° F. The winters are relatively dry with cold temperatures. The extreme minimum recorded is -25° F, and an average minimum for January of 8° F. The frost free period is approximately 110 days.

The prevailing winds are from the west and southwest with large local variations in lower levels because of mountain and valley wind patterns. The general drainage flow is from the Roan Plateau northward to the White River; therefore, the wind direction would be southerly when local flows predominate during the cooler part of the day when strong inversion conditions exist.

The mean maximum mixing depth of the Basin is about 400 meters in January and approximately 3,200 meters in July. A high frequency of night inversions, particularly during the fall and winter seasons, limits atmospheric dispersion.

c. Geology and Mineral Resources

(1) Tract U-a.--The general geology of the tract is described in section II, volume I of this Environmental Statement. The strata in Tract U-a dip northwestward at about 200 feet per mile (Figure II-32). There are no significant surface faults in the area. Oil shale thicknesses in Tract U-a are unknown because there has been no core drilling in the tract. It is estimated that the average thickness of the oil shale sequence that averages 30 gallons of shale oil per ton is about 45 feet thick. This is based on extrapolation of oil-yield assay data from core holes outside the tract and mechancial logs from exploratory wells within the tract. Overburden above the Mahogany Zone ranges from 550 to 1,225 feet and the average is approximately 850 feet. The shale oil resource recoverable from the tract by underground mining methods is estimated to be 244.4 million barrels. Nahcolite is

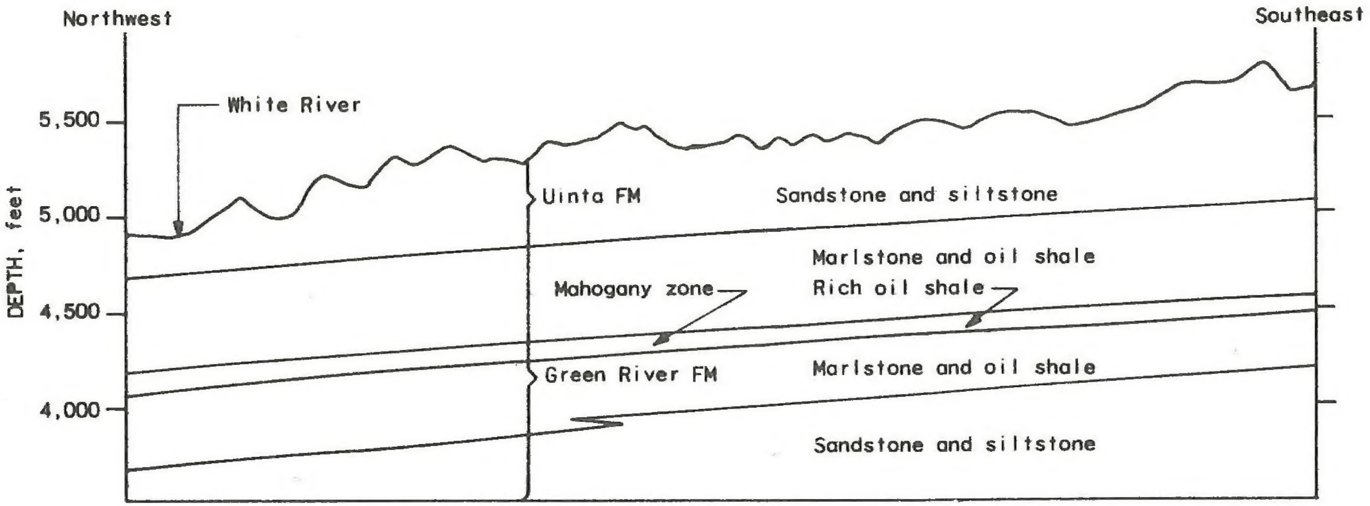


Figure II-32.-Representative Section for Tracts U-a and U-b.

probably present in the tract as very thin lenses or beds and small pods. There are no reports of significant amounts of bituminous sandstone in the tract, surface or subsurface, and no obvious gilsonite veins. The Southam Canyon field has produced gas from the Wasatch formation in Tract U-a. Although the Uinta formation produces gas in some parts of the Uinta Basin, it is very unlikely that commercial amounts of gas underlay Tract U-a.

(2) Tract U-b.--The general geology of the tract is described in section II, volume I of this Environmental Statement. The strata in Tract U-b dip westward and northwestward at 200 to 400 feet per mile (Figure II-32). There are no significant surface faults, but there is much evidence of jointing, especially in the beds of the upper Green River formation. Assayed samples from core holes in Tract U-b show the average thickness of oil shale yielding an average of 30 gallons of oil per ton to be approximately 50 feet. Overburden above the principal oil shale beds ranges from 300 to 1,250 feet and the average is about 700 feet. The shale oil resource recoverable from the tract by underground mining methods is estimated to be 265.8 million barrels. Nahcolite occurs as very thin lenses or beds and small pods in the upper part of the Green River formation. No oil or gas has been discovered in the tract and there is no known occurrence of significant amounts of bitumen in sandstone. One narrow gilsonite vein, less than 2 inches wide, outcrops in the west-central part of the tracts.

d. Water Resources

Tracts U-a and U-b adjoin each other and are described as a unit. The tracts are within 1 mile of the White River, and water is available for use (See Volume 1, Chapter II). Mean flow of the White River in this reach is about 700 cfs, and the weighted average dissolved-solids concentration is about 400 mg/l. Water could also be obtained from Green River and Flaming Gorge Reservoir by diverting at a point on the Green River about 30 miles to the west of the tracts.

Ground water occurs above and in the oil shale, but data are not available on possible yields of wells in the aquifers, or the quality of water that might be developed, although the yields probably will be small. Figure II-33 shows the general availability of ground water in northeastern Utah. One well record in the vicinity of the tracts reported "fresh" water at a depth of 600 feet. The ground water probably moves through the tracts in a northwesterly direction and is tributary to the White River (3).

Detailed data are available for only one test well in the area, WOSCO exploratory hole Ex. 1 in sec. 36, T. 9 S., R. 20 E., about 25 miles northwest of Tract C-a. Data on the yield and chemical quality of water for this test well are presented in Tables II-31 and II-32. Weir (1970) reported that three thin water-bearing zones were penetrated below the Mahogany Zone. The total yield of these zones during a jetting test was only 16 to 19 gpm, and the well flowed 5 gpm at the land surface. Samples of water from the well ranged in dissolved solids from 37,000 to 72,700 mg/l.

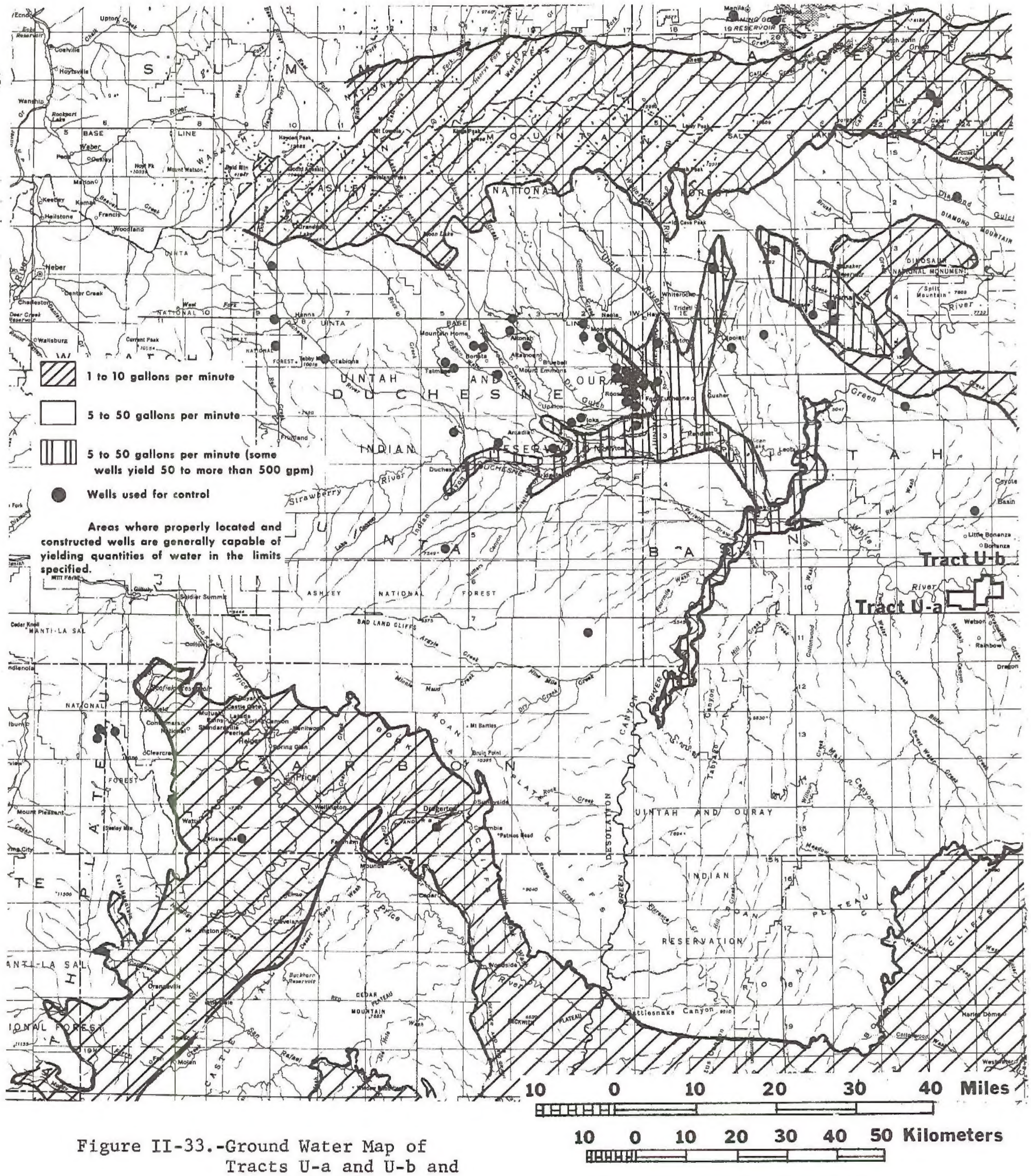


Figure II-33.-Ground Water Map of Tracts U-a and U-b and Surrounding Area.

Source: Reference (4).

The yields of several water wells and springs in the Uinta Basin and the concentration of dissolved solids in the water are presented in Table II-32 (Volume I, Chapter II). The maximum yield of wells and springs in the oil shale areas was 225 gpm from a spring in the Uinta formation. The maximum yield of water wells and springs in the Green River formation, according to Feltis (1966), was 140 gpm.

The ground water supply in the oil shale areas is so small it could not support a significant oil shale industry. Pumping rates of a few tens to a few hundreds of gallons per minute should be adequate to keep mines dewatered in Tracts U-a and U-b.

e. Fauna

Proposed test-lease Tracts U-a and U-b contain a healthy association of wildlife species, including mule deer, mountain lion, coyote, bobcat, rabbit, chukar partridge, dove, and various raptors, as well as numerous small bird and mammal species. The tracts contain habitat of specific value as deer winter range, and sustain about 50 hunter-days use by sportsmen each year. Important bald and golden eagle nesting and roosting sites are present along drainage escarpments, and the general area is occasionally frequented by the rare prairie falcon. Waterfowl,

aquatic furbearers, and various species of sport fish utilize the White River system. Catfish are found in the White River adjacent to the tracts. 1/

Without oil shale development, or other development that would impact upon these species, the land area involved could be expected to retain much of its current productivity for domestic livestock and the various wildlife species on a sustained yield basis. Some additional industrial activity related to expanded oil, gas and gilsonite exploration and extraction, however, may be anticipated and would likely result in a further deterioration of primitive qualities, as well as a general loss of wildlife habitat value.

f. Soils and Vegetation

Tracts U-a and U-b contain four identifiable soil units, each having distinctive plant communities. The following sites occur as approximate percentages of the total tract area, in percent:

Pinyon-Juniper Woodland -55

Salt Desert Breaks - 25

Loamy Saltdesert - 5

Rough Broken Land - 15

Following is a description of each site:

1/ For a more complete discussion of the fauna of the Uinta Basin, see Chapter II of Volume I.

(1) Pinyon-Juniper Woodland

(a) Soils: Soils are generally shallow, 10 to 20 inches deep, over a calcareous sandstone and siltstone type bedrock. They are moderately fine to moderately coarse textured and have a moderate moisture intake rate. Available moisture holding capacity is moderate to low. Fertility level is moderate to low.

(b) Vegetation: Sparse stand of junipers (occasional pinyon pine) with bitterbrush, serviceberry, Indian rice-grass, needle-and-thread grass, muttongrass, and a variety of forbs being the most apparent plants. Ground cover is generally less than 20 percent.

(c) Physical Condition: Site is fragile. Erosion is moderate to severe. There is typically heavy runoff during intense rainstorms.

(2) Salt Desert Breaks

(a) Soils: Soils are quite variable ranging from light textured loams to clay loams, and in many places there are many stones on the surface and in the profile. Soil depth varies from zero to several feet.

(b) Vegetation: Four-wing saltbush, winterfat, greasewood, Galleta, junegrass, Indian rice-grass, needle-and-thread grass, and annual forbs are the predominant plants on this site. Junipers occasionally occur on the site. Ground cover ranges from 10 to 20 percent.

(c) Physical Condition: Site is fragile. Runoff during heavy rainstorms is high. Erosion hazard is moderate to severe depending on ground cover and slope.

(3) Loamy Saltdesert

(a) Soils: These soils are generally moderately deep to deep with a loam to clay loam texture. They have a moderate to good water holding capacity and a moderate to slow water intake rate. These soils generally occur on gently sloping to moderate slopes. Fertility levels are moderate.

(b) Vegetation: Shadscale, four-wing saltbush, winterfat, budsage, galleta, salina wildrye, Indian rice-grass, needle-and-thread grass and forbs are the predominant plants on this site. Ground cover is 20% to 25%

(c) Physical Condition: This is a fragile site. Erosion hazard is high if vegetative cover is destroyed. This site occurs on gentle to moderately sloping areas.

(4) Rough Broken Land

This site consists mainly of the steep canyon walls. The sides of the canyons are a series of narrow terraces that have nearly vertical walls of sandstone and siltstone. On these narrow terraces, a thin mantle of stony soil supports a sparse growth of juniper, big sagebrush, black sage, bull-grass, Indian rice-grass, and bluegrasses. Runoff and erosion can be quite high during intense summer rainstorms.

Tracts U-a and U-b. Important plants occurring in these tracts are listed in Table II-9. Characteristic vegetation is shown in photos, Figures II-25 and II-26.

Table II-9.-- Plants Occurring on Tracts U-a and U-b

Forbs

Scientific Name	Common Name	Site 1/
Aster spp.	Aster	SDB
Astragalus spp.	Loco	PJW, LS, SDB
Calochortus spp.	Sego lily	SDB
Castilleja chromosa	Indian paintbrush	SDB
Chrysopsis villosa	Hairy goldaster	PJW
Delphinium nelsoni	Larkspur	SDB
Eriogonum spp.	Wild buckwheat	SDB
Erigeron spp.	Daisy	SDB
Gilia aggregata	Gilia	PJW, SDB
Gutierrezia sarothrae	Broom snakeweed	PJW, LS
Halogeton glomeratus	Halogeton	LS
Haplopappus acaulis	Stemless goldenweed	PJW
Lesquerella spp.	Bladderpod	PJW
Optuntia spp.	Prickly pear cactus	LS
Penstemon spp.	Penstemon	PJW
Phlox spp.	Phlox	PJW, LS, SDB
Salsola kali	Russian thistle	PJW, LS

Table II-9.-(continued)

Scientific Name	Common Name	Site[1]/
	Forbs	
Sphaeralcea coccinia	Globe mallow	PJW, LS, SDB
Solidago petradoria	Rock goldenrod	PJW
Zygadenus elegans	Death camas	SDB
	Grasses and Sedges	
Agropyron inerme	Beardless bluebunch wheatgrass	PJW, SDB
Agropyron smithii	Western wheatgrass	PJW, SD
Aristida longiseta	Three awn	PJW, SD, LS
Bouteloua gracilis	Blue grama	SD
Bromus tectorum	Cheatgrass	PJW
Carex spp.	Sedges	PJW
Elymus salinus	Salina wild-rye	PJW, LS, SDB
Hilaria jamesii	Galleta	PJW, LS
Koeleria cristata	Junegrass	SDB
Oryzopsis hymenoides	Indian ricegrass	PJW, LS, SD
Poa fendleriana	Muttongrass	PJW
Poa secunda	Sandberg bluegrass	PJW
Sitanion hystrix	Squirreltail	PJW, LS, SDB
Sporobolus cryptandrus	Sand dropseed	PJW, LS, SDB
Sporobolus airoides	Alkali sacaton	SDB
Stipa comata	Needle-and-thread	PJW, SD

Table II-9.-(continued)

Scientific Name	Common Name	Site[1/]
	Shrubs and Half-Shrubs	
Artemisia tridentata	Big sagebrush	LS
Atriplex canescens	Fourwing saltbrush	SDB
Cercocarpus montanus	Mountain mahogany	PJW
Chrysothamnus viscidiflorus	Low rabbitbrush	PJW
Cowania mexicana	Cliffrose	PJW
Ephedra spp.	Mormon tea	SDB
Eurotia lanata	Winterfat	LS
Purshia tridentata	Antelope bitterbrush	PJW
Rhus trilobata	Skunkbush	PJW
Yucca spp.	Yucca	PJW
Symphoricarpos tetonensis	Snowberry	PJW
	Trees	
Juniperous osteosperma	Utah juniper	PJW, SDB
Pinus edulis	Pinyon pine	PJW, SDB

1/ The abbreviations listed under this column are:

PJW - Pinyon-juniper woodland
SDB - Salt desert breaks
LS - Loamy saltdesert
RBL - Rough broken land

g. Grazing

Tracts U-a and U-b are in a winter sheep range utilized by about 1,400 sheep each year. Approximately 1,460 animal unit months (AUM) of this grazing is on the tracts. The present use rate is about 7 acres/AUM. In addition, approximately 21,000 sheep trail through Tract U-b twice each year along the main county road and Southam Canyon Road.

The area is subject to periodic infestations of poisonous weeds including loco weed and halogeton. Loco weed thrives after a favorable wet summer and is grazed in its green stage in the winter.

Potential for increased forage production by either management systems or vegetative manipulations is quite limited. Disturbed soil areas are susceptible to rapid invasion by halogeton.

h. Esthetics

Tracts U-a and U-b are characterized generally by desert shrub and pinyon-juniper trees to form a highly aesthetic semi-desert landscape. Wildlife and domestic animals utilize the area for winter grazing. They are often visible from travel routes. Erosion has produced unusual and interesting scenery on the rugged canyon walls along the White River.

i. Recreation

There are no developed recreation facilities in the area. Recreational use of the land in the general area is presently quite light with an estimated 50 visitor days and consists mainly of hunting (deer, rabbit, and chukar partridge), rock-hounding, and sightseeing. Recreational use of the White River is light--a few river runners and fishermen.

In addition to identified wildlife habitat values, the Utah tracts possess recreational value inherent in their relative isolation from commercial development. Although the eastern portion of the lease unit is bisected by an unimproved county highway and a gilsonite transmission pipeline, the general area retains a basically primitive quality. The dissected and eroded terrain has a scenic beauty enjoyed by recreationists.

j. Archaeological and Historical Values

There are no known archeological or historic sites on the tracts, but there are several points of interest located near the sites.

Two rock overhangs with evidence of the Fremont culture, a farming group of Indians dating in the 11th Century A.D., were found within one-half mile of the White River at the County Bridge crossing. There may be other evidence, possibly some

pithouse village sites, in the rest of the main canyon and near the mouths of the watered side canyons emptying into the White River. Historical sites of importance are present in the area immediately adjacent to the proposed use area. These are at the road crossing of the White River (Ignacio Stage Stop and Old Bridge) and in the gilsonite mining area. The sites of the mining camps of Rainbow and Watson, the remains of the narrow-gauge Uintah Railway, which served the area until 1938, and the remains of many abandoned gilsonite workings represent interesting relics of a rare mining activity, all are adjacent to the south boundary of the development area.

Although there are no historic sites listed for Uintah County, Utah, in the National Register of Historic Places, the Colorado Historic Society recognizes the historic significance of the abandoned Uintah Railroad and related sites located along the Colorado-Utah State lines.

k. Socioeconomic Status

With the exception of a few oil and gas wells of the Southman Canyon Field and access roads on Tract U-a, there is no existing economic or social development on the Tracts U-a and U-b.

1. Possible Off-Site Waste Disposal Areas for Tracts U-a and U-b

A possible solid waste disposal area is along the canyon of Evacuation Creek in and just south of Tract U-b (Fig. IV-8). The creek is a north-flowing creek tributary to the White River that has an average relief between valley floor and ridge crest of about 300 feet. The length of drainage from mouth to headwaters is about 30 miles, and the drainage system encompasses an area of approximately 300 square miles. Evacuation Creek heads at an elevation of about 8,700 feet along the crest of the Roan Plateau and joins the White River at an elevation of about 5,000 feet. Although the gradient for the entire length of the creek averages 170 feet per mile, the possible waste disposal area has an average gradient of 50 feet per mile.

Topography of the area is characterized by a narrow valley floor bounded by steep slopes and cliffs. Numerous small dry washes with steep gradients dissect the walls of the main canyon. Precipitation in the area amounts to about 8 to 10 inches per year. Stream flow is intermittent along Evacuation Creek, and during some periods the stream bed is almost dry. Only during short periods after torrential rains does the stream carry appreciable amounts of water.

The upper part of the Green River formation and the lower part of the Unita formation are exposed along the canyon. The exposure of the Green River formation consists principally of rich shale of the Mahogany Zone in the Green River formation which underlies the entire area. The exposure of the Unita formation is principally sandstone and siltstone.

Bituminous coals in the Mesa Verde Formation, at considerable depth, underlie the entire Uinta Basin, and oil and gas have been encountered in the Lower Green River, Wasatch, and Mesa Verde Formations; however, none has been produced in the area proposed for solid waste disposal.

Much of the upper canyon walls is exposed bedrock or has little soil cover, and thus plant life is sparse. What soil is present is a sandy loam along the valley floor of Evacuation Creek and its tributaries.

The Bureau of Land Management classifies the vegetation along Evacuation Creek in two major types - Type 13, Saltbush, and Type 4, Sagebrush. Major species in the Saltbush type are shadscale, four-wing saltbush, black sage, rabbitbrush, and greasewood, and such grasses as galleta, Indian rice-grass, squirreltail, bull grass, needle-and-thread, and cheat-grass. Important species in the Sagebrush type are big sage, shadscale, winterfat, greasewood, and rabbitbrush and the same grasses as those in Type 13 with the addition of western wheatgrass. In places there are also patches of halogeton and locoweed, both of which are poisonous to livestock.

Wildlife inhabiting the proposed disposal site are a small resident mule deer herd, a few migratory deer during winter months, cottontail rabbit, jackrabbit, coyote, badger, bobcat, chukar partridge, dove, magpie, sparrow, and horned lark and raptors such as golden eagle (winter), prairie falcon, and redtailed hawk.

The area proposed for spent shale disposal has mixed ownership. The E½E½W½ sec. 25 and all of section 36 are patented with no minerals reserved; only ditches and canals are reserved. The E½ of sec. 35, T. 10 S., R. 24 E., is in the State of Utah application

U-10485, now pending. Also, within this same part of section 35 are two layers of pre-1920 claims of unknown ownership, two post-1920 placer mining claims that are now being contested by the U.S. Government, and somewhere in the section are two lode mining claims (D&S claims) located August 17, 1954. The SE¼NE¼, SE¼SE¼ sec. 6, T. 11 S., R. 95 E. is covered by a layer of pre-1920 placer claims of unknown ownership. This same part of section 6 is in the State of Utah selection application U-3088 now pending. The remainder of section 6 is patented with no minerals reserved--only ditches and canals are reserved.

4. Wyoming Tracts W-a and W-b (Washakie Basin)

a. Physiography

Tract W-a is located on the southwestern flank of the Washakie Basin and includes part of the Kinney Rim. (Figure II-15 and II-34). A southwest-facing escarpment, below the Kinney Rim, extends along the western side of the tract. To the east of the escarpment the topography is controlled by resistant strata that form dip slopes inclined northeastward. A few narrow, steep-sided drainages have been cut into this slope. Altitudes within the tract range from about 7,200 feet at a point below the Kinney Rim escarpment and on the dip slope in the eastern part of the tract to about 8,200 feet on the Kinney Rim. Maximum relief along the escarpment is about 900 feet.

Tract W-b is located on the southwestern flank of the Washakie Basin. The west-facing escarpment below the Kinney Rim extends approximately along the eastern margin of the tract (See Fig. II-16). East of the escarpment the surface slopes rather uniformly eastward

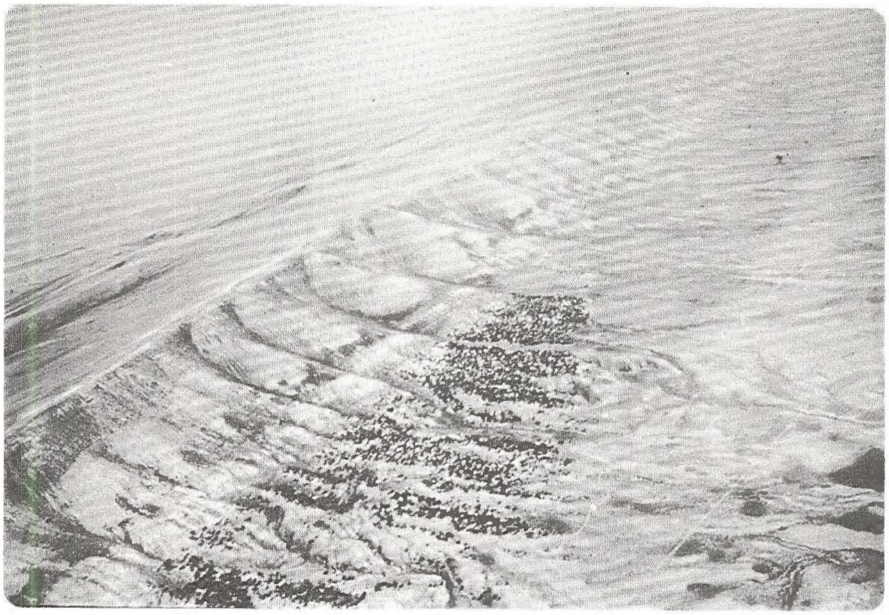


Figure II-34.--Aerial view of Kinney Rim, Washakie Basin, Wyoming, looking southeast from Section 2, T. 14 N., R. 100 W., toward Wyoming sites W-a and W-b in upper center and right portions of the photographs.

except where broken by narrow east-trending drainages. The altitude along most of these drainages is less than 7,100 feet near the eastern boundary to about 8,200 feet on Kinney Rim. Greatest relief on the escarpment along the west side is about 700 feet.

b. Climate

The climate of these tracts is semiarid with annual precipitation ranging from 10 to 12 inches, which occurs mostly in the winter and early spring. Temperatures fluctuate from -40° to 90° F. Extreme temperatures recorded in the area are 55° F below 0 and 107° F.

The growing season ranges from 70 to 100 days between killing frosts, which is 28°F or less. On the average, from 65 to 75 percent of the days are sunny; the percentage is lower during spring and winter and higher in the summer and fall. Winds are relatively strong over the area especially along the top of the Kinney Rim. The prevailing wind direction is from the west. During the cooler times of the day down-slope winds are from the southwest, and during the warmer times of the day winds blow from the northeast. The most severe weather conditions occur with outbreaks of Arctic air, which bring northeasterly winds and extremely cold temperatures.

The mean maximum mixing depth is approximately 100 meters in January and 3,000 meters in July.

c. Geology and Mineral Resources

The general geology of the area in and around the tracts is described in Section II, Volume I, of this Environmental Statement. Details for the tracts are given below. Rocks in the tracts strike

to the northwest and dip to the northeast at rates of 700 to 900 feet per mile on the west to more than 1,800 feet per mile on the east. Two north-trending normal faults less than 1 mile long displace the oil shale by as much as 100 feet. The west side is downfaulted.

U.S. Bureau of Mines Washakie Basin Core Hole 1 is in the northern part of Tract W-a and assay values of cores from the Laney, Wilkins Peak, and Tipton member of the Green River formation are assumed to be representative of the value of the oil shales of these members underlying both tracts. U.S. Bureau of Mines Washakie Basin Core Hole 1A was drilled 1.5 miles west of Tract W-a and assays from this core were considered to be representative of the value of the oil shales in the Luman Tongue of the Green River formation underlying the tracts (Figure II-35).

There is no oil shale underlying the tracts that averages 30 or more gallons per ton in thicknesses greater than 10 feet. In the lower half of the oil shale bearing part of the Laney member, two zones 42 and 48 feet thick respectively, average 20 or more gallons of oil per ton and contain an in-place resource of about 130,000 barrels per acre. The uppermost 40 feet of the Wilkins Peak member averages more than 15 gallons of oil per ton and has an in-place resource of approximately 45,000 barrels per acre. The upper 30 feet of the Tipton member averages more than 15 gallons of oil per ton and has an in-place resource of approximately 35,000 barrels per acre. There is no overburden on the oil shale-bearing segment of the Laney member near the western margin of the tracts. The overburden

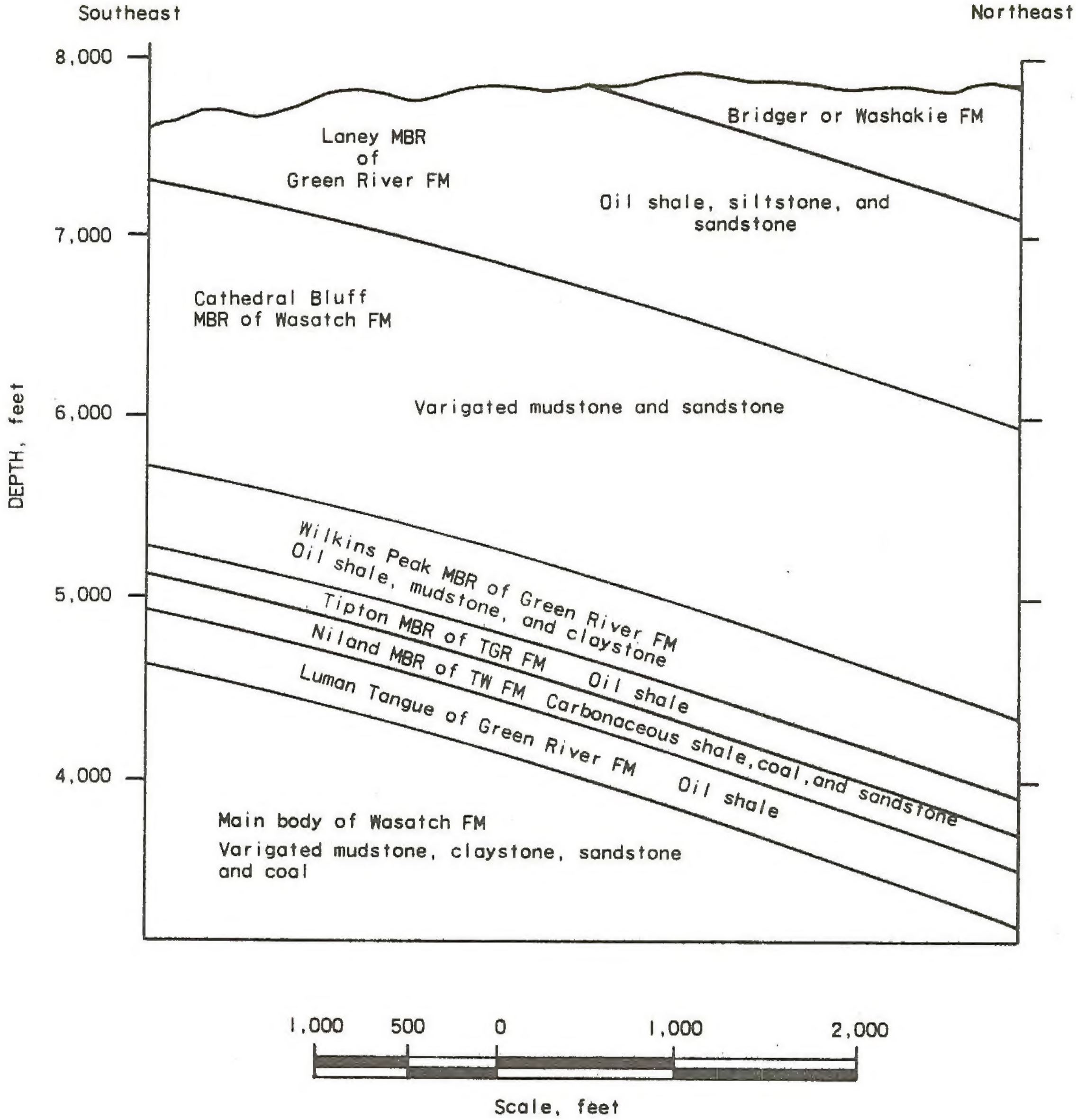


FIGURE II-35.-Generalized Section for Tracts W-a and W-b.

increases abruptly eastward to a maximum of 2,400 feet, the average of which is 600 feet. The minimum overburden on the top of the Wilkins Peak is 900 feet, the maximum 2,500 feet, and the average 2,200 feet. The minimum overburden on the top of the Luman is 1,600 feet, the maximum 5,600 feet, and the average 2,900 feet.

d. Water Resources

Ground water hydrology of the region in which Tracts W-a and W-b occur is described in a report by Welder and McGreevey (1966). Water occurs above, below, and probably in the shale, and deep water is under artesian pressure. Permeabilities of the aquifers probably are low. A ground water map of Tracts W-a and W-b is shown in Figure II-36.

Welder and McGreevey (1966) reported that ten wells which were drilled in the Laney Shale member ranged in yield from 0 to 200 gpm and that the maximum potential yield probably is not much greater than 200 gpm. The ground water supply is not adequate to support a large oil shale industry.

A pumping rate of a few hundred to a few thousand gallons per minute probably would be adequate to keep a mine dewatered.

Chemical quality of the ground water in the Laney member near the tracts is good, having a dissolved solids concentration of less than 1,000 mg/l. No data are available on water quality in the deeper members and the aquifer characteristics of all the oil shale beds are unknown.

Stream flow in the vicinity of the tracts is intermittent and is dependent largely upon snowmelt and runoff immediately after

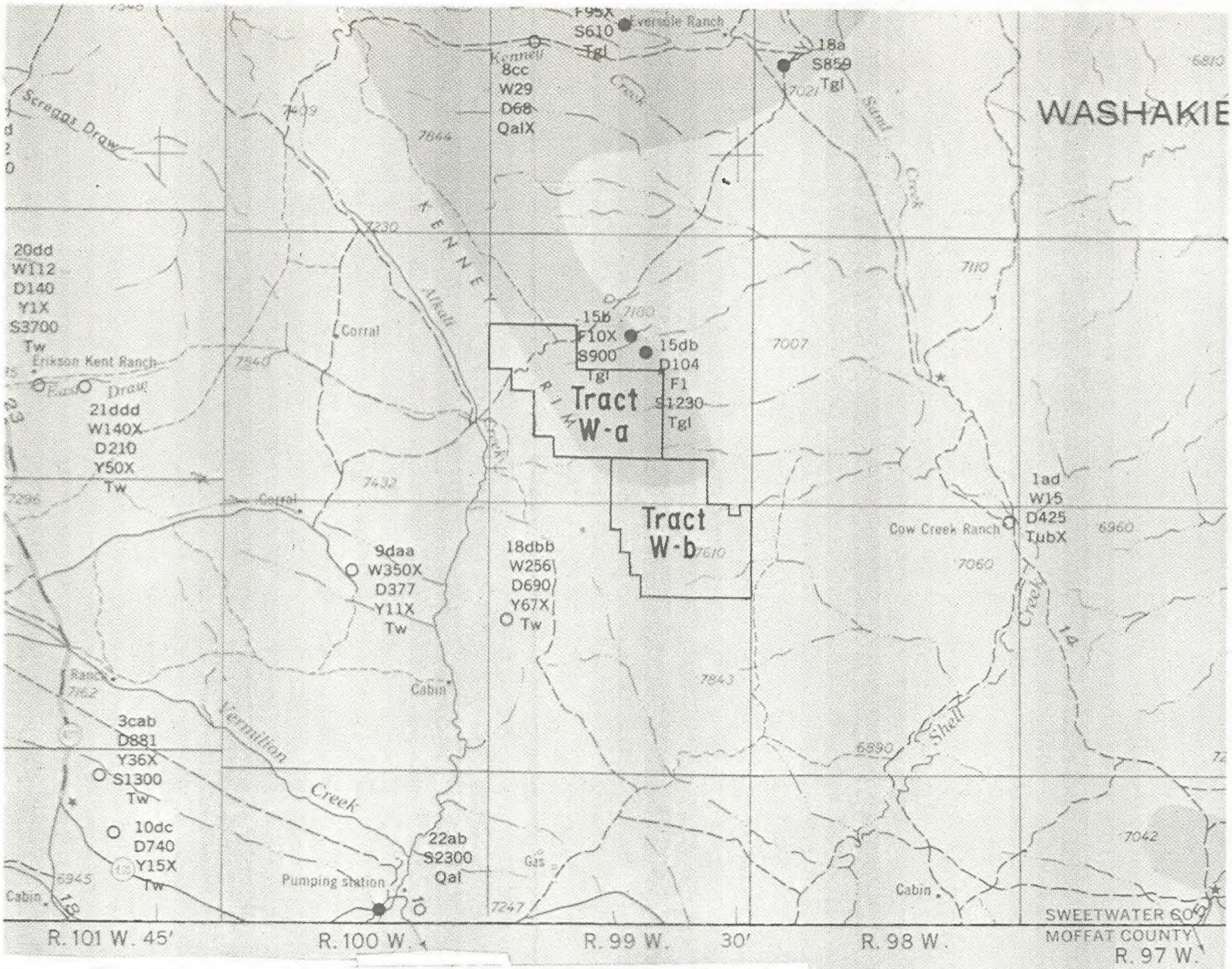


Figure II-36.-Ground Water Map of Tracts W-a and W-b and Surrounding Area.

Source: Reference (5).

SCALE 1:250 000

5 0 5 10 15 20 MILES

5 0 10 15 20 KILOMETERS

1955 MAGNETIC DECLINATION FOR THIS MAP VARIES FROM 16°00′ EASTERLY FOR THE CENTER OF THE WEST EDGE TO 15°00′ EASTERLY FOR THE CENTER OF THE EAST EDGE. MEAN ANNUAL CHANGE IS 0°03′ WESTERLY

EXPLANATION

HYDROLOGIC SYMBOLS

7100

Piezometric contour

Altitude to which water will rise in wells in the Wasatch and Battle Spring Formations in the Great Divide Basin. Contours are very generalized because of multiple artesian zones, particularly in the Wasatch Formation, and dashed where projected.

Water-quality area

Water of specific conductance less than 1,500 micromhos per centimeter (approximately 1,000 ppm total dissolved solids) is probably available from at least one aquifer; other aquifers may have water with a higher specific conductance. In many of the designated areas, wells are less than 1,000 ft in depth. Data, although inadequate, indicate that most of the ground water outside the designated areas has a specific conductance greater than 1,500 micromhos.

Drainage Divide

WELL AND SPRING DATA

D820 — Non-flowing well; W+51 — Flowing well; F32 — Spring

12abc	Section number segment of well number. Explanation of well numbers given in text
W+51	Depth to water below or head above (+) land surface, in feet
D820	Depth of well, in feet
F32	Natural flow of artesian well or spring, in gallons per minute
Y60	Yield of pumped well, in gallons per minute; generally not the maximum yield
S1100	Specific conductance of water in micromhos per centimeter at 25° C; based principally on field determinations
Tw	Geologic source of water
x	Data marked by "x" are questionable

GEOLOGIC SOURCE SYMBOLS

Qs	Wind-blown sand
Qal	Alluvial deposits
Ql	Lake deposits
Tn	North Park(?) Formation
Tbp	Browns Park Formation
Tbi	Bishop Conglomerate
Tu	Tertiary rocks, undivided
Tub	Uinta and Bridger Formations
Tgl	Laney Shale Member of the Green River Formation
Twc	Cathedral Bluffs Tongue of the Wasatch Formation
Tgt	Tipton Tongue or Tipton Shale Member of the Green River Formation
Tw	Wasatch Formation
Tbs	Battle Spring Formation
Tf	Fort Union Formation
Kla	Lance Formation
Kle	Lewis Shale
Kmv	Mesaverde Formation
Kal	Almond Formation
Ke	Ericson Formation
Kr	Rock Springs Formation
Kbl	Blair Formation
Kba	Baxter Shale
Kc	Cody Shale
Kf	Frontier Formation
K€r	Lower Cretaceous through Cambrian rocks

91a

storms. Small amounts of ground water are discharged from a few springs. Water supply for development of Tracts W-a and W-b could be obtained from Fontenelle Reservoir by diverting at a point on the Green River about 45 miles northwest of the tracts.

e. Fauna

Despite the rather harsh conditions presented on the high, northern desert habitat, a broad variety of wildlife species utilize these tracts on Kinney Rim intermittently, seasonally, or on a year-long basis. Included are mule deer, antelope, wild horse, mountain lion, coyote, bobcat, rabbit, sage grouse, dove, golden eagle, and several hawks, as well as numerous small bird and mammal species. No angling habitat exists on the tracts.[1/]

The Kinney Rim area comprises very important antelope and deer range in Wyoming. The top of the rim and its northern slopes - where the tracts are located - are used by both species in the spring, summer, and fall. The south side is used year round, but is of primary importance as winter range. The majority of the Kinney Rim area lies within the Black Butte - Kinney Rim antelope management area. There is a large exchange of antelope between this area, the South Wamsutter area, and Colorado. Permanent springs on the north side of the rim provide an abundant water supply for wildlife. The water may be the most important habitat factor for deer and antelope. Along the southwestern slope of the rim, the Wyoming Game and Fish Commission and Bureau of Land Management have jointly participated

1/ For a more detailed discussion of the fauna of the Green River Basin, see Chapter II of Volume I.

in a project to build reservoirs to increase the water supply. A large percentage of the wild horse population is also found in this area.

While hunting pressure and harvest figures are not available for the specific tracts, the following figures are indicative of the quality of antelope hunting in the area (Black Butte-Kinney Rim antelope management area). In 1970, 150 antelope were harvested which represents an 85 percent success rate by permit holders, who hunted an average of only 1.6 days. In 1971, the harvest of 154 antelope represented a success rate of 92 percent and an average of only 1.4 days hunting. During the winter of 1971-1972, a 36 percent winter loss occurred in the antelope herd. Antelope permits were cut to 50 in 1972. The harvest was only 46, but this still represented a 92 percent success rate and an average of only 1.2 days hunting.

Currently, much of the land within the Kinney Rim area is covered by active oil and gas leases, giving rise to the potential for some increased industrial activity related to exploration and extraction. Although this may result in some future impact, it is assumed that without oil shale development, or other development that would impact there species, the Kinney Rim site could be expected to retain much of its current wildlife productivity for the foreseeable future.

f. Soils and Vegetation

Tracts W-a and W-b contain four identifiable sites, each having distinctive kinds of soils and plant communities. The following sites occur as indicated as percentages of the total tract area, in percent:

Very shallow	-	64 percent
Saline upland	-	21 percent
Shallow sandy	-	14 percent
Saline lowland	-	1 percent

Each of the sites is described below:

(1) Very Shallow:

(a) Soils.- Soils are 10 to 15 inches deep over sandstone and shale. In places, bedrock is exposed. Texture varies from loam. They have an alkaline to strongly alkaline reaction.

(b) Vegetation.- Dominant plants include bluebunch wheatgrass, thickpike wheatgrass, black sage, mountain mahogany junegrass, bluegrasses, squirrel tail, and annual forbs. Ground cover ranges from 25 to 33 percent.

(c) Physical condition.- Topography is generally steep with slopes mostly in the 10 to 20 percent range. Erosion is slight to moderate.

(2) Saline Upland:

(a) Soils.- Soils in this site are shallow to moderately deep (20 to 40 inches) over shale and sandstone. Texture varies from sandy loam to light clay loam and reaction from alkaline to strongly alkaline. Permeability is moderate; moisture holding capacity is moderate. Fertility level is low to moderate.

(b) Vegetation.- Predominant species are big sage, shadscale, saltbrush, western wheatgrass, Indian rice-grass, and forbs. Ground cover is 15 to 20 percent.

(c) Physical condition.- Topography is generally quite steep with slopes of 20 to 30 percent. Runoff is rapid, and erosion hazard is high.

(3) Shallow Sandy:

(a) Soils.- These soils are moderately sandy to sandy over sandstone, with many stones on the surface and in the profile. Water holding capacity is low. Fertility is low.

(b) Vegetation.- Predominant plants are shadscale, sagebrush, Sandberg bluegrass, Indian rice-grass, and bluebunch wheatgrass. Ground cover averages about 20 percent.

(c) Physical condition.- The site is fragile. Topography is moderately sloping with 5 to 10 percent slopes. Erosion is slight.

(4) Saline Lowlands:

(a) Soils.- These soils are generally deep and are loam to clay loam in texture. They are alkaline to strongly alkaline in reaction. Water intake is moderate to slow and water holding capacity is high. Fertility is low to moderate.

(b) Vegetation.- Inland saltgrass, basin wildrye, alkali sacaton, sedges, and greasewood are the predominant plants on this site. Ground cover is 20 to 25 percent.

(c) Physical condition.- Topography is gently sloping. Erosion is slight.

Land types such as shale badlands and sand dunes also occur in the basin.

Important plants occurring in these tracts are listed in Table II-10.

Table II-10.--Plants Occurring on Tracts W-a and W-b

Scientific Name	Common Name	Site 1/
	Forbs	
Achillea millifolium	Western yarrow	VS, SS
Antennaria rosea	Pussytoes	VS, SU
Aster spp.	Aster	VS, SS
Astragalus bisulcatus	Milkvetch	VS, SL, SS, SU
Castilleja chromosa	Indian paintbrush	VS, SS, SU
Crepis acuminata	Hawksbeard	SS
Eriogonum spp.	Eriogonum	SS, SU
Eriogonum pulcherrimus	Fleabane	VS, SS, SU
Iva axillaris	Poverty weed	SL
Lomatuim spp.	Biscuit root	VS
Muhlenbergia asperifolia	Alkali muhly	SL
Muhlenbergia richardsonis	Mat muhly	SL
Oxytropis lambertii	Pointvetch	VS, SU, SL
Penstemon spp.	Penstemons	SS
Phlox spp.	Phlox	VS, SS
Sedum spp.	Stone crop	VS
Sphaeralcea coccinia	Scarlet globemallow	VS
Viola spp.	Violet	VS
Zygadenus elegans	Death camus	SU

Table II-10.-(continued)

Scientific Name	Common Name	Site 1/
	Grasses and Sedges	
Agropyron dasytachyum	Thickspike wheatgrass	VS, SS
Agropyron smithii	Western wheatgrass	SS, SU, SL
Agropyron spicatum	Bluebunch wheatgrass	VS, SS, SL
Calamovilfa longifolia	Plains reedgrass	SS
Carex eleocharis	Needle leaf sedge	SL
Distichlis strica	Inland saltgrass	SL
Dryland sedge	Carex spp.	VS, SS
Elymus cinereus	Basin wildrye	SL
Koeleria cristata	Prairie junegrass	VS, SS
Oryzopsis hymenoides	Indian ricegrass	VS, SS, SU, SL
Poa canbyi	Canby bluegrass	VS, SS
Poa fendleriana	Mutton bluegrass	VS, SS
Poa secunda	Sandberg bluegrass	SU, SL, VS, SS
Puccinellia nuttallii	Nuttall's alkaligrass	SL
Sitanion hystrix	Bottlebush squirreltail	VS, SS, SU, SL
Sporobolus airoides	Alkali sacaton	SU, SL
Stipa comata	Needle and thread grass	VS, SS, SU
Stipa lettermani	Letterman's needlegrass	VS, SS

Table II-10.-(continued)

Scientific Name	Common Name	Site [1/]
	Shrubs and Half-shrubs	
Artemisia nova	Black sagebrush	VS
Artemisia tridentata	Big sagebrush	VS, SS
Artiplex canescens	Fourwing saltbush	SL
Artiplex nuttalli	Gardner's saltbush	SU, SL
Cercocarpus montanus	Mountain mahogany	VS
Chrysothamnus spp.	Rabbitbrush	VS, SS, SL
Eurotia lanata	Winterfat	VS, SS, SU
Oenothera spp.	Primrose	SU
Purshia tridentata	Antelope bitterbrush	VS
Rhus trilobata	Skunkbush	VS, SS, SL
Sarcobatus vermiculatus	Greasewood	SU, SL
	Trees	
Juniperous osteosperma	Utah juniper	VS, SS

1/ The abbreviations listed under this column are:

VS - Very shallow
SU - Saline upland
SS - Shallow sandy
SL - Saline lowland

g. Grazing

Tracts W-a and W-b are within an area grazed by sheep during the late fall, winter, and spring and by cattle during the summer and fall months. One cattle and two sheep grazing licenses are issued for this area. Approximately 1,350 animal unit months (AUM) of this grazing use is on the tracts. The present use rate is about 7.6 acres/AUM. In addition, an estimated 190 annual unit months of grazing use is made on the tracts by wild horses during a typical year.

Substantial numbers of wild horses range widely over the Washakie Basin, from Kinney Run to Flaming Gorge area. A recent census indicates approximately 1,200 horses in Washakie Basin and approximately 2,500 horses and burros in the area between Kinney Rim and the Utah line. Prevailing winds generally drift most of the snow off major portions of the area lying along and immediately east from Kinney Rim, including Tracts W-a and W-b. Consequently, the area is utilized by wild horses during periods of heavy snow accumulation.

The major livestock grazing problem in this area is the scarcity of water for proper grazing distribution. There are several excellent springs located a short distance east of the tracts. These springs will have to be preserved or substitute water sources provided if present grazing patterns are to continue on the approximately 30-square-mile dependent area.

Potential for increased forage production through management systems is estimated to be in the 20 to 40 percent range. Potential for increased forage production through vegetative manipulation is considered quite limited. Disturbed soils are susceptible to invasion by halogeton, a plant poisonous to livestock.

h. Esthetics

The aesthetics attraction of the basin is the land form, notably the Kinney Rim escarpment, which extends for about 20 miles, uncluttered and semiremote in character. The area is sparsely inhabited, and only few primitive roads exist.

i. Recreation

Tracts W-a and W-b are situated in a remote, undeveloped area with semiprimitive characteristics. The area is attractive for sport hunting, rock collecting, camping, and general sightseeing. Access is by roads originating at Interstate 80 approximately 25 to 30 miles to the north, from Wyoming State Road 430, about 15 miles west of the tracts, or from Powder Wash, Colo., 15 miles southeast of the roads.

It is estimated that, despite the sparsity of surrounding human populations and the absence of all-weather access, a total of several hundred man-days recreational use are expended annually within tract boundaries.

j. Archaeological and Historical Values

The Kinney Rim area is in the heart of the historic Wind River Shoshone and Commanche country. Indications are that campsite and animal kill sites might be found in the area dating from present to historic times back some 10,000 years or more.

There are presently no known archaeological or historic sites on the tracts.

The National Register of Historic Places lists no sites in Sweetwater County, Wyoming.

k. Socioeconomic Status

With the exception of unimproved roads on Tracts W-a and W-b, there is no existing economic or social development on the tracts.

C. References

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III. MINING AND PROCESSING OPTIONS ON SELECTED TRACTS

Volume I, Chapter I, of this Environmental Statement outlined the technology generally available for oil shale development. This section contains a more detailed discussion of that technology. Subsequent chapters of this volume examine the environmental consequence of such development.

Three systems of processing are considered to be technically feasible: (1) underground mining-surface processing, (2) surface mining-surface processing, and (3) in situ processing. Each of these is examined below.

A. Mining-Surface Processing Systems

The flow of materials through a "typical" mining-surface processing system producing 50,000 barrels of shale oil per day is shown in Figure III-1. Details of such a system are presented below. Subsequent sections of this chapter will examine specific resource requirements for a specific tract. In situ processing is discussed separately in Section B of this chapter.

1. Underground Mining

An underground view of an experimental oil shale mine is shown in Figure III-2 to illustrate the concept of room and pillar mining. This general system is expected to be applicable to the proposed tracts in either Colorado or Utah, although the configuration

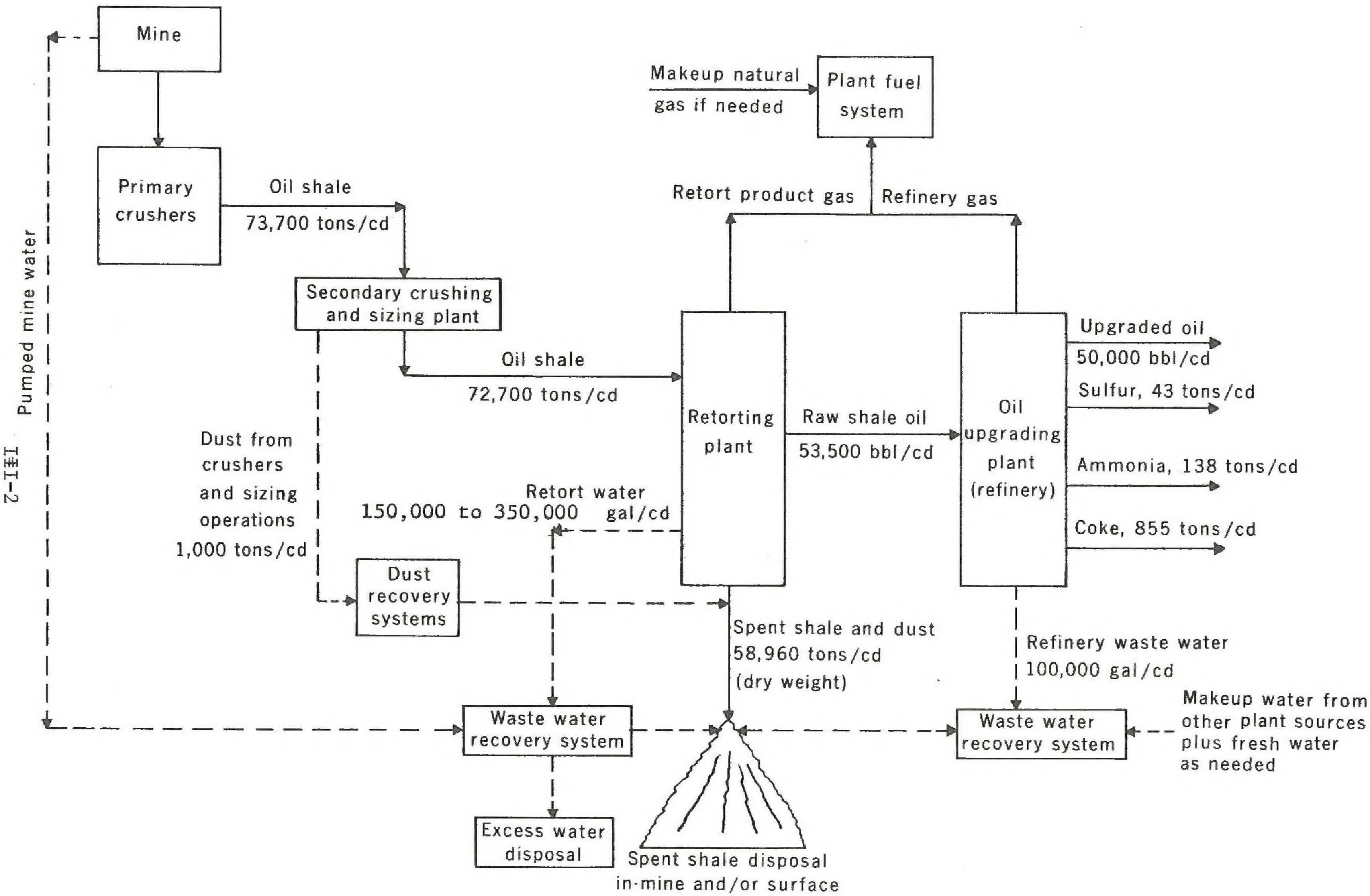

FIGURE III-1.--Flow Diagram of 50,000-Barrel-Per-Day Underground Oil Shale Mine and Processing Unit.

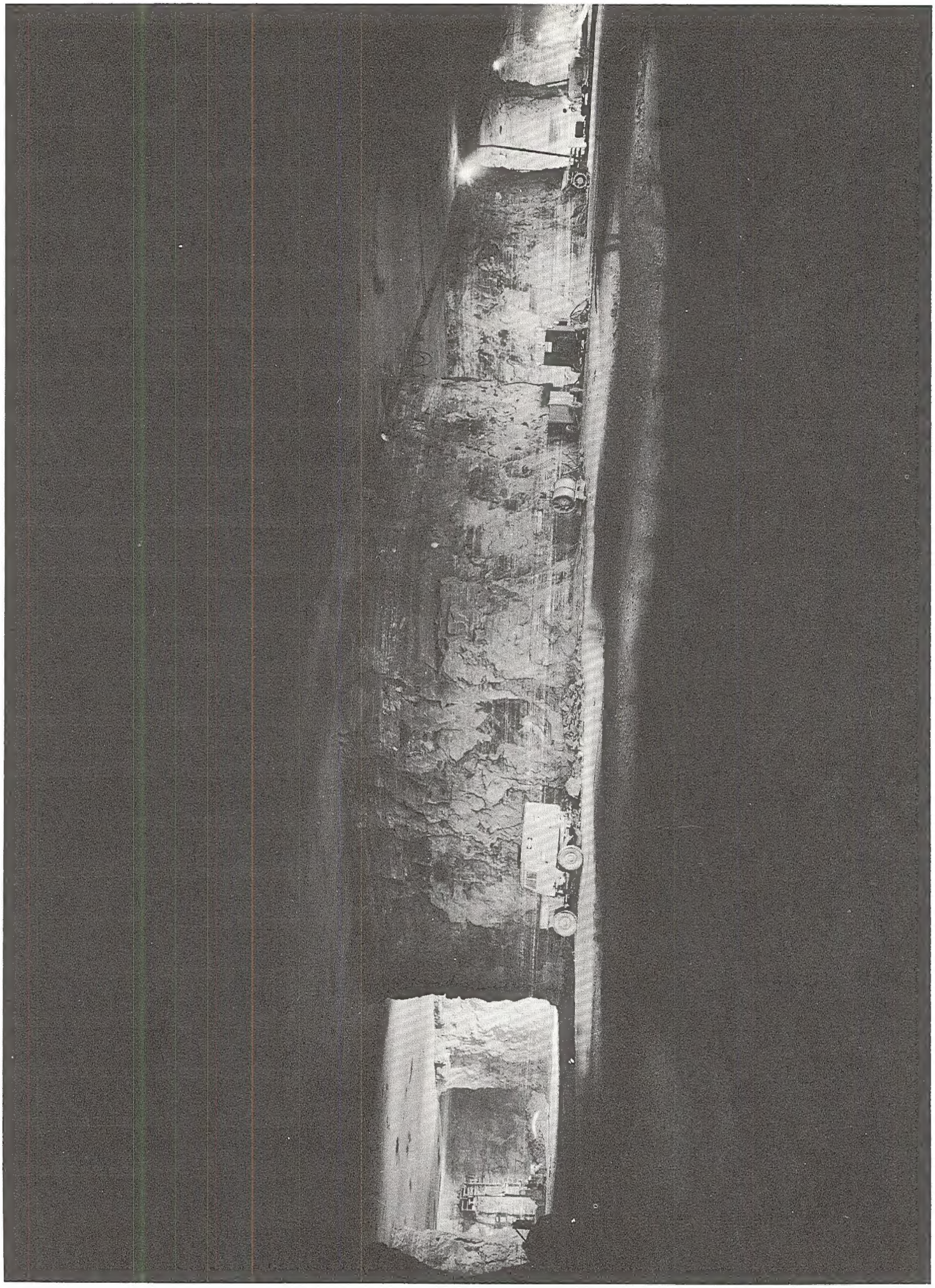

FIGURE III-2.--Experimental Oil Shale Mine Illustrating Room and Pillar System of Development.

of rooms and pillars probably would vary somewhat depending on actual site conditions as determined during the initial stages of development. As mined out areas become available, spent shale backfilling could begin. Spent shale in excess of the mined-out space available -- on the order of 40 percent of the total -- would require disposal in box canyons or other suitable surface locations, as discussed in Chapters II and IV for the prototype tracts.

The detailed diagrams and discussions that follow are based on typical parameters for an oil shale complex. It should be recognized that each actual operation, if it eventually occurs, may vary in some respects from the "typical" system in regard to processes and procedures used, flow rates, yields, and in other engineering details.

Entrance to the working area would be gained by 4 vertical concrete-lined shafts 20 to 30 feet in diameter. Each would be about 1,500 feet deep located near the center of the tract and sunk to about 150 feet below the bottom of the lower shale horizon. This would provide space for the sump, surge bins, and skip pockets. Dewatering wells and/or grouting would be used to reduce water flow into shafts and shaft stations. Shaft pillars would be designed to protect the installations from the effects of possible ground movement and/or ground subsidence. Percentage extraction is estimated to be 60 percent of the oil shale in place in the Mahogany Zone.

A system of main headings (30 ft. wide by 31 ft. high with 60 ft. barrier pillars between headings) would be driven on the top heading level to connect the shafts (Figure III-3). The center heading would be for the belt conveyor and the other two headings would be for ventilation and for transportation of mine personnel, supplies, and equipment.

The general mining plan would be to mine one side of the mine on the advance to the tract limits and to mine the other side of the mine on the retreat. With this system, full production of 73,700 tons per day (30 gallons per ton) would be achieved within the shortest time. Development headings would also consist of three entries that would be identical in size and function to the main headings.

Production panels would be mined by a 30-foot-high-heading and a 20-foot-high-bench. Rooms and pillars would be 60 ft. wide (Figure III-4). Ramps would provide access from haulage level to bench level.

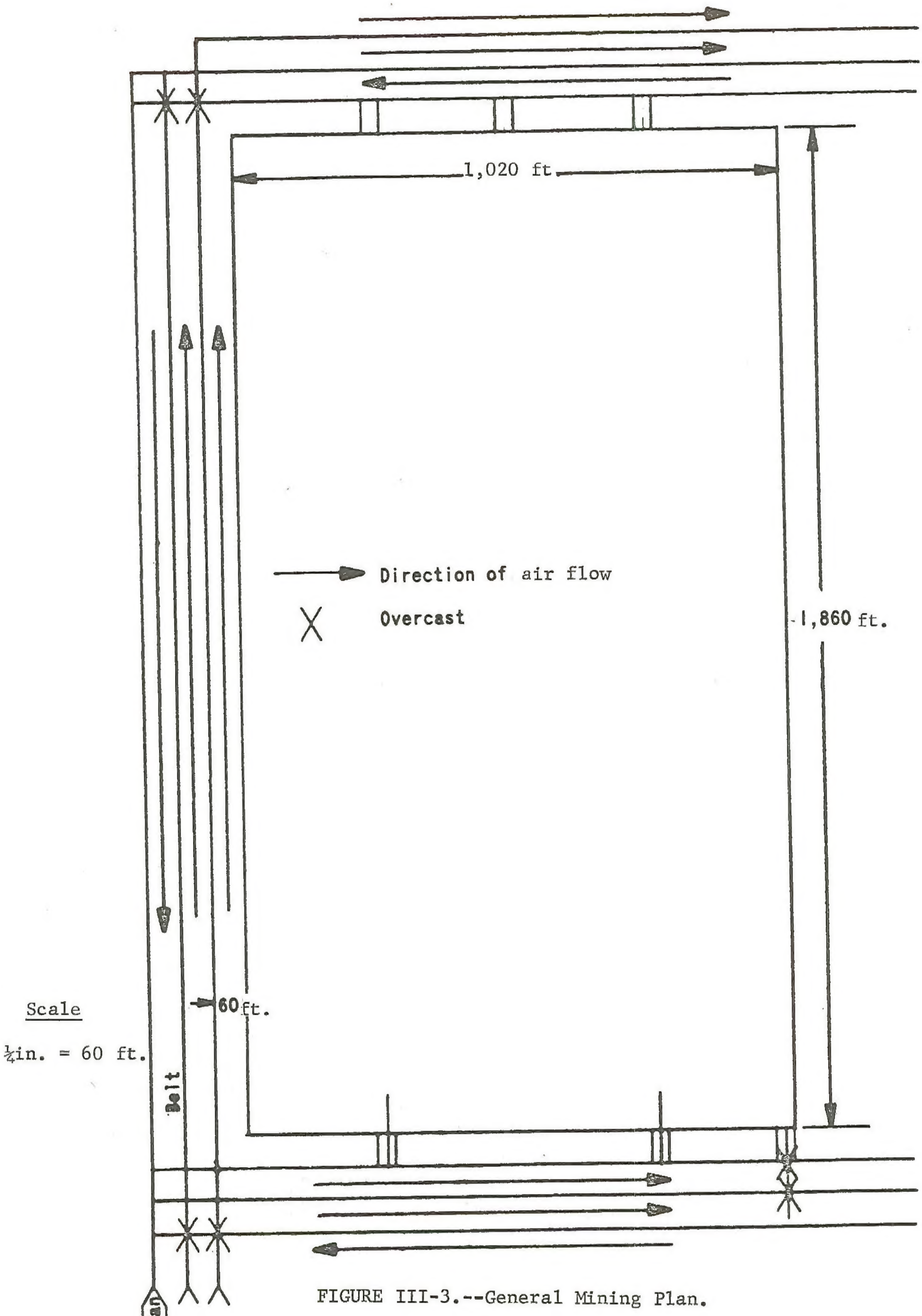

FIGURE III-3.--General Mining Plan.

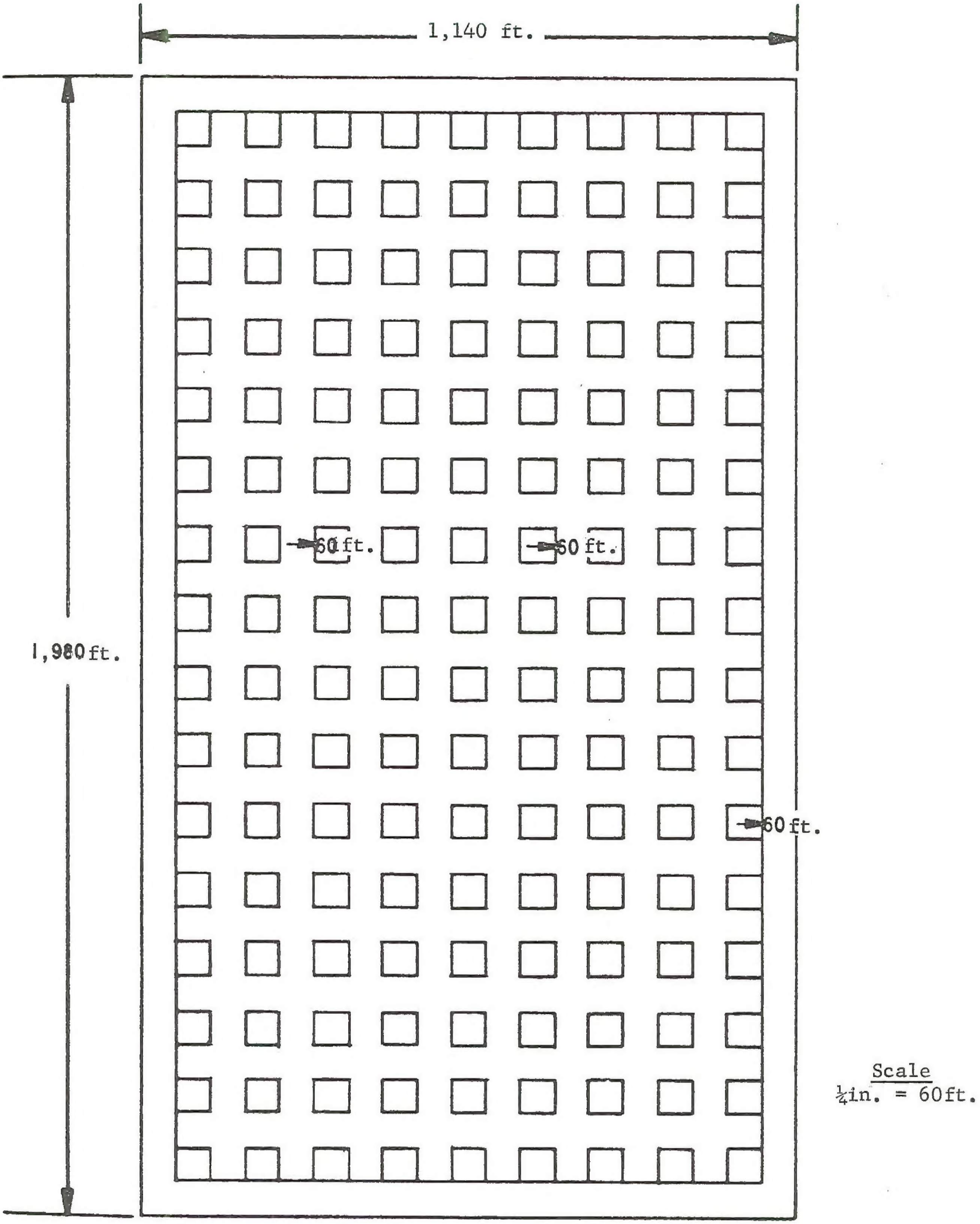

Figure III-4.--Plan View of a Panel.

Heading or benching rounds would be drilled with drill jumbos using percussion, rotary, or rotary-percussion drills. Rounds would be blasted with ANFO-type explosives and the broken shale loaded into diesel-powered trucks with front end loaders. Trucks would haul the shale to portable crushers at the panel entrance where it would be reduced to minus 10.5 inches. Crusher discharge would be carried by a 60-inch conveyor belt; dust from mining and primary crushing operations would be controlled by water sprays.

The roof would be supported by rock bolts. Size and spacing of these supports would be determined by on-site tests as would be the size of barrier pillars between panels and main headings. Sixty-foot pillars are chosen for the purpose of this estimate.

Ventilation requirements would be determined by measurements of air volumes, pressures, velocities, dust, and noxious gas content. For the purpose of this example, two 1 million cfm[1/] fans would be located underground in the intake shafts. Air would be exhausted through the shale-hoisting shafts. Direction of ventilation air flow would be controlled by doors, regulators, overcasts, and bulkheads. Mined-out production panels would be backfilled with processed shale and bulkheaded off.

Crushed shale would be transported by the 60-inch main haulage belt to underground surge bins having a capacity of about 50,000 tons. Shale from the surge bins would be fed to skip pockets from which it would be hoisted in skips to secondary crusher feed bins on surface.

Methods for mining the lower zone will have to be developed, although some modified form of the room-and-pillar system is envisioned.

1/ Cubic feet per minute.

A barrier or sill pillar would be left between the mining horizon and the overlying leached zone to reduce the inflow of ground water. The mining layout, size and location of rooms and pillars would have to be developed. Because of the depth and the need for barrier pillars, percentage extraction is estimated to be 50 percent of the oil shale in place.

By 1975, it is assumed that shafts would have been completed and mining of the main headings would have begun in the Mahogany zone. By 1978, full production of 73,700 tons per day would be reached. To maintain full production from the Mahogany zone with an extraction ratio of 60 percent will require that an area with a radius of about 1 mile be mined in about 5 years.

Mining of the lower zone would start below the mined-out section of the Mahogany zone in 1978 and would attain a maximum of about 63,000 tons/day by 1988. The remaining 10,700 tons per day needed for full production would be produced from the Mahogany zone which will enlarge the mine area at the rate of about one eighth acre per day.

About 60 percent[1/] of the processed shale could be back-filled. This offers several advantages over surface disposal; it would reduce the impact on the surface environment and would help stabilize the mine structure. Backfilling the mined-out openings would therefore reduce hazards from subsidence and reduce ground movements which might increase inflows of ground water. If mined-out areas are not backfilled, surface subsidence can be expected to be of larger

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1/ The amount of backfill depends on the type of spent shale, degree of compaction, moisture content, and mine volume used, and could be 50-65%.

magnitude, and possible disruption of natural surface drainage may occur.

When backfilling, processed shale will probably be transported by conveyors or by truck for disposal in mined-out, underground areas. Alternatively it may be transported into the mine in the form of a water slurry. If slurried, main pipelines would carry the slurry from the surface at a velocity that would hold the solids in suspension, and plastic pipelines would deliver the slurry from the main lines into the abandoned mining panels. As the slurry is discharged away from brattice-covered timber dams, solids in the slurry would settle out. Drain water would be collected and pumped to settling sumps near the shafts, then pumped to the surface where it could be reused in the slurry operations.

2. Surface Mining

Of the selected tracts, only Colorado Tract C-a is believed to be amenable to surface development. The mining plan for this hypothetical mine was therefore developed around the specific characteristics of that tract and scaled to a production level of 100,000 barrels per day.

On this tract, the mine would be restricted to the tract limits and the ultimate pit slope would be 45 degrees. A specific development plan for a mineral property of the size being considered would require extensive, detailed engineering studies of the type normally used for actual commercial mining.

The figures used to describe the hypothetical plan are typical of actual design parameters and have been developed to estimate probable environmental impacts.

Overburden ranging from about 100 ft. to 800 ft. in depth and averaging 450 ft. totals an estimated 7.1 billion tons for a pit laid out with a 1:1 final average slope (45 degrees). Of this amount, about 256 million cubic yards of loose waste material could be disposed offsite in Water Gulch which lies to the west of the tract. While this area has been delineated as a possible disposal site, it is not intended to conclude that Water Gulch will be used. Prior to selecting disposal sites, detailed engineering, geological and environmental studies would be conducted and submitted for approval. Because of the thickness of overburden in this area, future mining of oil shale would probably be by some type of underground method.

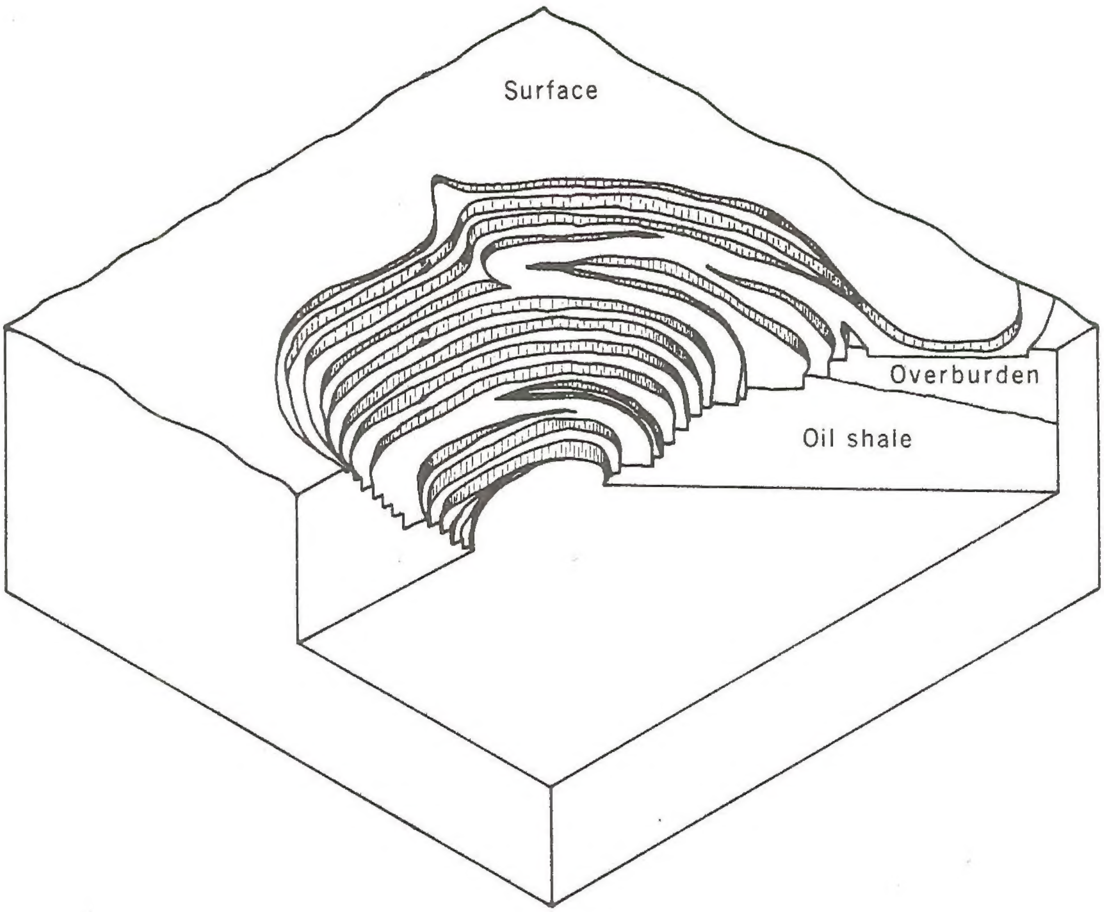
Several years after full-scale production, sufficient space should be available in mined-out sections of the pit to allow for pit disposal of some of the processed shale and overburden. The time when a backfilling operation can proceed without interfering with pit operations and the amount of material that can be disposed of in this manner will depend upon the characteristics of the particular tract (topography, depth of overburden, and thickness of minable oil shale). In the mining plan and schedule of operations for the illustrative mine, the figure of 16 years was used.

Because the economic operations are not clearly defined at present, the cut off limit for oil shale grade cannot be determined until actual operations commence. Since oil shale assaying less than an assumed economic grade of 30 gallons/ton will need to be excavated as the pit is opened up, grades that are not considered of economic value at present could be separately stockpiled in such a manner that they could be recovered, blended, and processed at some future time.

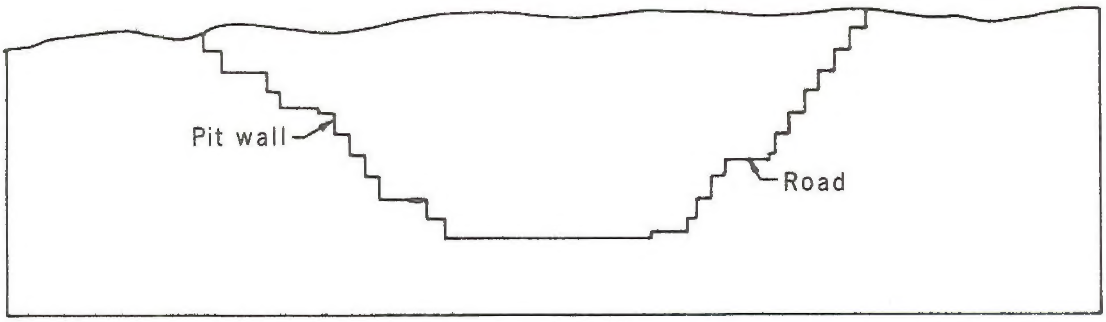
Total tonnage of shale of 30 gallons/ton or more, of lower grade oil shale, and of waste rock is estimated at 11.8 billion tons. Of this, about 62 percent would be oil shale of 30 gallons/ton or more.

Because of the depth of overburden, sufficient time must be allowed for initial prestripping of overburden in advance of actual production of oil shale. Further, the initial pit must be laid out so that several bench levels can be developed to provide enough working faces to meet daily production rates (Figure III-5). Because of these considerations, mine production would start well in advance of processing; a large amount of bench-development oil shale would be stockpiled for recovery as processing requirements expand.

Initial prestripping down to the Mahogany zone would amount to about 150 million tons of overburden, which would require an average rate of 30 million tons per year, or a rated capacity of 82,000 tons per day.



Isometric



Section

FIGURE III-5.--Schematic Open Pit Development.

A 1:1 average slope (45^{o}) and about a 1.4:1 average working slope (35^{o}) were selected for the conceptual pit. Bench height was 40 ft and minimum width of operating berm was 110 ft. This matches well with a 15 cubic yard electric shovel and 55 ton diesel-electric rear-dump truck combination.

Much of the overburden and all of the oil shale would probably need to be drilled and blasted. Crawler rotary drills powered by diesel engine-generators would be used to drill blast holes of about 9 7/8 to 12 1/2 inches in diameter. Blasting would be with ANFO type explosives.

Initially, the overburden and waste rock would be hauled by truck to the disposal area. After about 16 years, when space becomes available, waste would be backfilled into mined-out areas of the pit.

Blasted pit-run oil shale would be hauled to primary crushing stations in the pit. Each station would consist of a truck dumping hopper, grizzly, vibrating grizzly feeder and a large gyratory crusher. Crushed oil shale would be fed to a 60-inch slope conveyor belt. Two or more conveyor-crusher units would probably be required. Other conveyor systems beyond the pit limits would transport the material to the processing complex, stock-pile and waste areas.

Benches 40 ft high would be mined by shovels in 40 ft wide cuts; about 1600 cubic feet of material would be available for each foot of advance. On this basis and at 14 cubic feet/ton, about 114 tons would be available per foot of advance. Assuming that a 30-day supply of oil shale should be maintained for mining ahead of the shovel, about one linear foot of ore face should be available for each 4 to 5

tons of production. Taking the higher factor of 5 tons and an average production of 147,400 tons/day, advance stripping must proceed until about 29,000 ft. of oil shale face can be maintained in advance of the shovels.

Surface disposal off site[1/] in the dry canyons immediately west of the Cathedral Bluffs would be feasible and, for the purpose of this illustration, was chosen as the disposal area. Processed shale could be transported to the disposal area in dampened condition via conveyors. Alternatively, a slurry form of transport could be employed as detailed below for illustrative purposes.

From 2.36 to 2.74 million cubic feet per day of the processed shale could be moved as a processed shale-water slurry in a gravity pipeline extending from the plant site and through a tunnel to the lower ends of canyons selected for filling. Figure III-6 shows a schematic of the conceptual disposal system. Processed shale at the rate of 118,000 tons[2/] per day would be crushed, screened and slurried (about 50 percent solids) at the plant site, and pumped into the primary disposal pipeline (50-in. inside diameter reinforced concrete pipe).

1/ Off-site disposal of overburden or spent shale might take place on Federal, State, or private lands. Permission to use Federal lands for disposal would require a Special Land Use Permit, issued by the Secretary of the Interior. Under 43 CFR 2920.4 "each permittee will be required to pay to the Bureau of Land Management, in advance, a rental determined by the authorized officer as the fair market value of the privileges granted". Disposal on State or private lands would similarly be an expense to the lessee. The cost of shale oil will thus reflect the cost of any off-site disposal.

2/ It is assumed that the density of the processed shale could vary between 86 and 100 lbs/cubic foot.

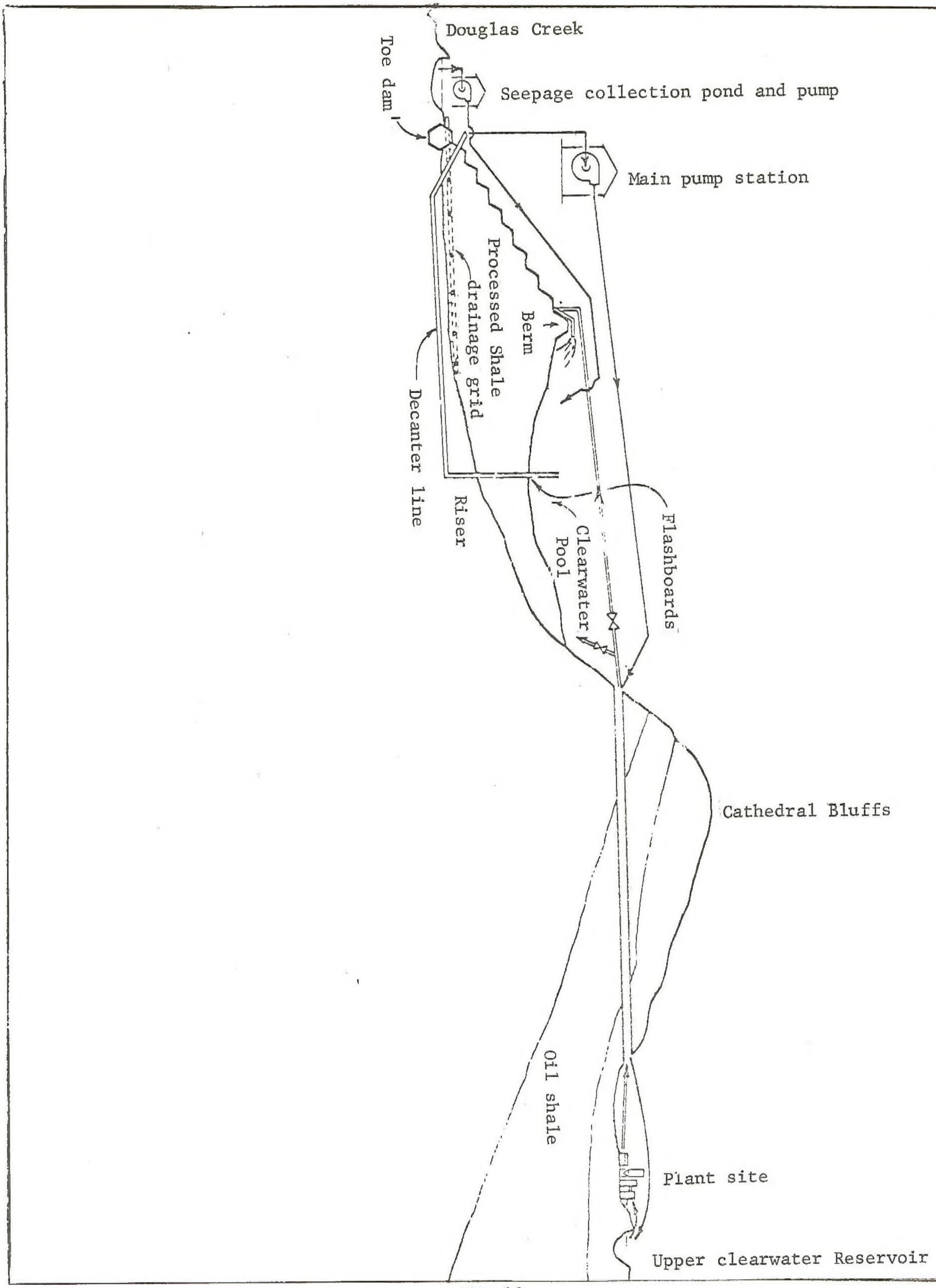


FIGURE III-6. - Processed Shale Disposal System (Cross-Section Scematic).

A small earthen dam would be constructed near the mouth of a dry canyon and a smaller impoundment dam would be built below to contain seepage and runoff water. The slurry of processed shale and water would be discharged behind the first dam until the material had been built up to the crest. Then, a second berm would be built above the filled-in area, the pipe discharge system relocated, and the process repeated. The slurry would be deposited behind the dam, where the solids would settle out and the water, containing dissolved solids, would be pumped back to the plant site for reuse in the slurry.

The moisture content of the processed shale in the dam should reduce to about 20 percent by weight or less through drainage and desiccation. Compaction to a dry density of about 90 pounds per cubic foot could be reached. This would be about optimum for maximum dry density as measured by the standard Proctor compaction test. Formation of a natural pozzolana-cement type compound in the processed shale should aid in reduction of leaching.

Because flash floods may occur, a system of dams and canals would be necessary to intercept fresh runoff water and route the water around the dam for discharge into Douglas Creek.

During the life of the mine, the volume of processed, compacted shale would fill several canyons. As one canyon was filled, disposal would begin in the next canyon. Revegetation of the first canyon would begin as soon as the disposal process was completed.

Seepage water from the disposal dam would be collected in the seepage collection pond below the toe dam and pumped to the main pond.

Clear water, decanted from the surface of the tailings pond would be fed through a system of vertical risers and decanter lines to a major pump station from where it would be pumped to a reservoir at the plant site for re-use. An estimated 8 to 13 cubic feet per second of water could be required for this system of disposal.

3. Crushing, Screening and Briquetting

A schematic diagram of a crushing and screening operation sized to serve a 50,000-barrel- per-day complex is shown in Figure III-7.

In the case of an underground mine, the primary crushing facilities would probably be located in the mine; in the case of open-pit mining, the primary crusher station or stations, at about twice the total capacity shown in Figure III-7, would probably be located on the pit floor and be relocated from time to time as the mining operation progressed. In each case, the purpose of locating the initial crushers near the mining area is to minimize the distance over which the relatively wide size range, mine-run material, containing some massive blocks weighing several tons, would have to be conveyed or otherwise transported. The discussion that follows refers specifically to an underground mining situation; however, beyond the primary crushing stage, the crushing/sizing operations would be essentially the same regardless of mining system, except that total capacity would be doubled for the envisioned open pit case as mentioned above. The run-of-mine

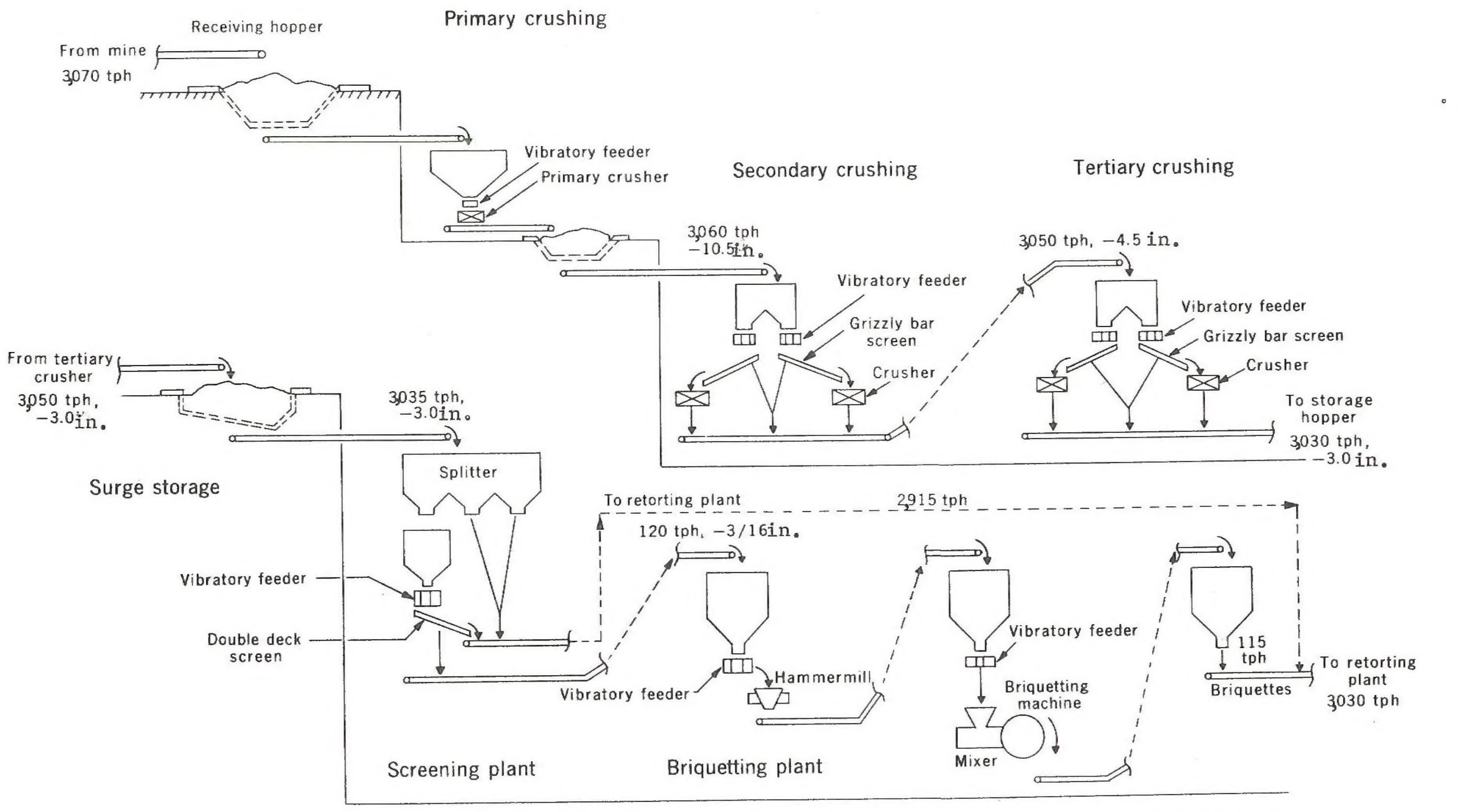


FIGURE III-7.--Crushing, Screening, and Briquetting Plants, Schematic Flow Diagram (Two Identical Plants).

shale is transported directly to concrete receiving hoppers at the primary crushing plant. The hoppers are sized to provide 24-hour surge storage. Shale from the bottom of the hoppers is conveyed to the primary crusher feed bin at a rate of 3,070 tons per hour. Conveyors, 60 inches wide and 200 feet long, are required. The shale is dumped into the three parallel storage bins and is fed by magnetic vibratory feeders to the primary gyratory crushers where the size is reduced to minus 10½ inches. The crushed shale is conveyed to underground surge bins for a 24-hour holdup.

The shale from the bottom of the surge bins is transported to the secondary crusher feed bins on 48-inch wide belt conveyors. The shale at a rate of 3,060 tons per hour is fed from the storage bins to double hopper feed bins in the secondary crushing system. From each surge bin the shale is fed by magnetic vibratory feeders to the vibrating grizzly bar screens. The minus 4½ inch material, 47 percent of the total, falls through the screen to the product conveyor from the secondary crushers. The shale is then conveyed back under the screens, picking up the material that originally passed through the vibrating grizzlies, and is transported to tertiary crushing.

Three feed hoppers in tertiary crushing receive the shale. Magnetic vibratory feeders are used to feed the vibrating screens; the minus 3-inch material is screened out and falls on the product conveyors from the tertiary crushers. The plus 3-inch material, 35 percent

of the total, then feeds to the tertiary crushers, where it is reduced in size to minus 3 inches. The shale is then transported by the return conveyors, picking up the material that passed through the 3 inch screens, to the main conveyor and is finally conveyed to surge storage hoppers with a capacity of 3 day's production.

From the surge storage hoppers 3,035 tons per hour of shale is fed to the splitter in the screen house. Sixty-five percent of the shale by-passes the screens and feeds directly to the surge bin for feeding to the retorting plant. The double-deck screens (in parallel plus one spare) remove the minus 1-inch material on the top screen and minus 3/16 inch material on the bottom screen. The screens are fed by vibratory feeders. The shale from the top of the screens (2,915 tons per hour) feeds to the conveyor that transports feed to the retorting plant. The fines from the screens are conveyed to the briquetting plant, from which an additional 115 tons per hour of briquets are fed to the retorting plant. Briquetting would not be needed in the case of a TOSCO-type plant since the TOSCO retort can accommodate all fines directly.

The fines are conveyed to the briquetting surge bin No. 1 on a 20-inch belt conveyor. This fine shale is then fed by vibratory feeders to two parallel hammer mills where it is reduced in size to minus 14-mesh. From the mills the shale is conveyed to surge bin No. 2. A vibratory pan feeder is used to feed the milled shale to two parallel double-paddle horizontal mixers where it is mixed with crude oil, which serves as a binder. From the mixers the material

flows by gravity into the briquetting machines. The briquettes are moved by conveyors to a surge bin and then are conveyed back to the retort feed system (Figure III-8).

The overall dust losses in the crushing and screening operations are estimated to be 1.3 percent of the shale handled. Half of these fines are assumed to occur in crushing and transporting and the balance in screening. Except for an estimated 35 pounds per hour actually lost to the atmosphere as true airborne particulates, the dust lost from the process flow streams would be collected periodically, dampened, and disposed of with the processed shale from the retorting plant.

4. Retorting

In the following discussion, gas combustion retorting is assumed; other processes could, of course, be used.

The retorting plant, comprised of 6 individual, 56-foot diameter retorts for a 50,000-barrel-per-day complex, would be located in close proximity to the mine mouth. A schematic of an individial retort is given in Figure III-8.

The shale from the 3-hour surge bins and the briquettes from the briquetting plant are fed to the retort feed hoppers, atop the retorts, using belt conveyors equipped with automatic trippers to feed the individual retorts.

For 50,000 bbl/day shale oil production, six retorts each process 505 tons per hour of shale and briquettes and produce 370 barrels per hour of crude shale oil, 4.04 million standard cubic feet per hour of excess low heating value gas (about 100 Btu's per cubic foot), and 410 tons per hour of spent shale.

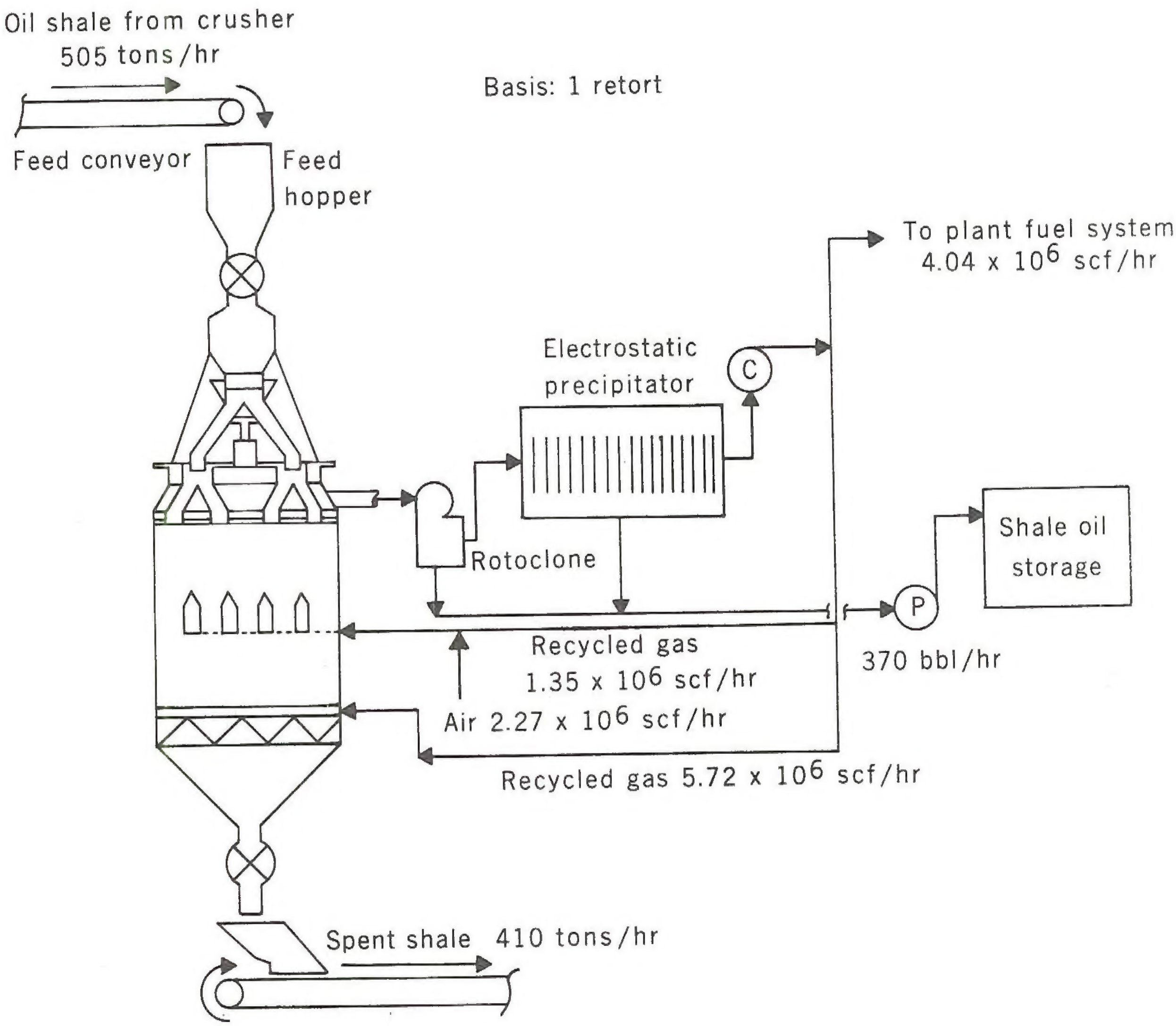


FIGURE III-8.--Schematic Flow Diagram of Retorting System.

The shale bed in each retort is maintained at a depth of approximately 18 feet. The fresh feed at the top of the unit is preheated by the off gases from the retort combustion zone. The shale, at a rate of 500 pounds per hour per square foot of cross sectional area, moves through the preheat zone of the retort. The combustors, located near the midpoint of the shale bed, are fired with recycled low Btu-gas burned with air to heat the shale to retorting temperature.

About 82 percent of the recycled gas is fed to the bottom of the retort and is utilized to cool the spent shale to about 200°F prior to discharge. The remainder of the recycled gas with the combustion air is fed directly to the combustor.

The gases from the top of the retorts, with entrained crude shale oil, flow through rotoclones and electrostatic precipitators for separation of gases and oil. The crude is then pumped to storage tanks located at the retorting site. The low Btu gas is compressed for recycle and for use as fuel elsewhere within the processing complex. The crude shale oil (370 barrels per hour) flows from each retort by pipeline to upgrading storage tanks.

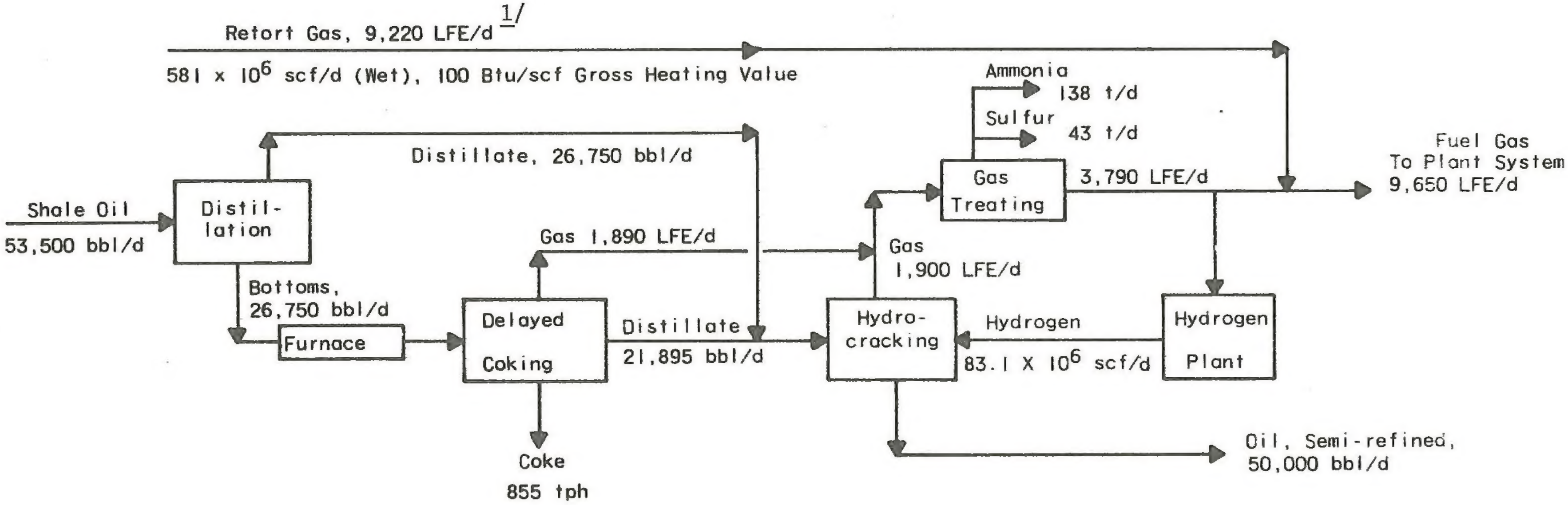
5. Upgrading

Upgrading the shale oil would be similar whether surface mining or underground methods are employed. Since a 50,000-barrel-per-day plant is described, the values would need to be doubled for 100,000 barrels per day. It should also be recognized that upgrading

facilities could vary materially from those that are detailed below for purposes of quantified illustration. The system described represents rather intensive upgrading, resulting in a premium-quality pipeline oil product and maximum recovery of sulfur and ammonia byproducts. Other possible operating conditions and variations in crude shale oil and individual processes chosen would cause variations in product quality, yields, and flow rates. However, environmental considerations associated with upgrading of the crude shale oil would be generally unaffected.

The crude oil from storage is heated in a tube still and then charged to a distillation column (Figure III-9). The crude charge is separated into a heavy fraction and vapors, these fractions being approximately equal in quantity. The overhead product (vapor) is cooled and depropanized to yield a distillate product (26,750 barrels per day). The uncondensed gases, consisting of C_3 and lighter gases, are utilized as described later.

The bottoms (heavy fraction) from the distillation columns are fed through a heater to delayed coking units. The feed is preheated to about 940° F prior to being charged to the drums. The distillate product from the coking units is cooled and depropanized and then, together with the distillation overheads, is charged to hydrogenation. The coke from the drums, 855 tons per calendar day, is stored for sale. The hydrocrackers operate at 835° F and 1,500 psig and produce a product containing about 60 volume percent material in the gasoline boiling range. The



1/ LFE is Liquid Fuel Equivalents With Gross Heating Value 6.3 X 10^6 Btu

FIGURE III-9.--50,000-Barrel-Per-Calendar-Day Refinery.

uncondensed gas is used for plant fuel. The liquid hydrogenated product, having a gravity of about 42° API, is pumped to storage as the major sales product.

The gas streams from the hydrogenation, delayed coking, and distillation units contain the sulfur and nitrogen available for recovery, the recoverable materials being in the form of hydrogen sulfide and ammonia. The streams are processed in the following manner. An ammonia-water wash is used to remove the hydrogen sulfide from the coker and distillation gases, and a water wash is used to extract the ammonia and hydrogen sulfide from the hydrogenation gas. The combined ammonia-hydrogen sulfide-water solution is then heated to 170° F to drive off the hydrogen sulfide which is scrubbed with sulfuric acid to remove traces of ammonia. The hydrogen sulfide is reacted with air in a Claus kiln to form sulfur which is recovered as a hot liquid and stored for sale. The ammonia-water solution is pressurized to 230 lbs/square inch gauge and heated to 330° F to liberate the ammonia, which is cooled, condensed, and stored for sale in liquid form.

About 89 percent of the washed gas from the gas treating plant is steam reformed to produce the hydrogen needed for hydrocracking. The gas used for hydrogen generation is converted to produce 76 percent of the hydrogen theoretically available with complete conversion of the gas. Using methane as an example (other hydrocarbons in the coker gas react in an analogous manner), the conversion involves two steps.

$$CH_4 + H_2O \longrightarrow CO + 3\ H_2 \qquad (1)$$

$$CO + H_2O \longrightarrow CO_2 + H_2 \qquad (2)$$

with the overall result being:

$$CH_4 + 2H_2O \longrightarrow CO_2 + 4H_2 \qquad (3)$$

The first reaction takes place in tubes at 50 lbs/square inch gauge and 1,400° to 1,500° F using a nickel catalyst and an excess of steam. The endothermic heat of reaction is supplied by burning retort gas in the furnace surrounding the tubes. The hydrogen yield then is increased by catalytic water-gas shift conversion at 800°F, as illustrated by equation (2) above. A hypersorber is used for hydrogen purification before compression and introduction to the hydrocracking unit.

The upgraded oil probably would be shipped via pipeline to a refining/marketing center outside of the oil shale region for final refining to yield conventional products.

B. In Situ Processing

A conceptual plan for a 50,000-barrel-per-day commercial operation is presented in Volume I. Specific application of this concept is included in the description of the tracts where this technique may be applicable and would involve flow requirements of the order of magnitude shown in Figure III-10. However, it should be noted that in situ processing is in the experimental phase of development and there is no assurance that commercial technology can be developed.

A number of in situ retorting experiments utilizing wellbores from the surface have been conducted during the past 20 years by both industry and government. Two major problems to date with this approach have been:

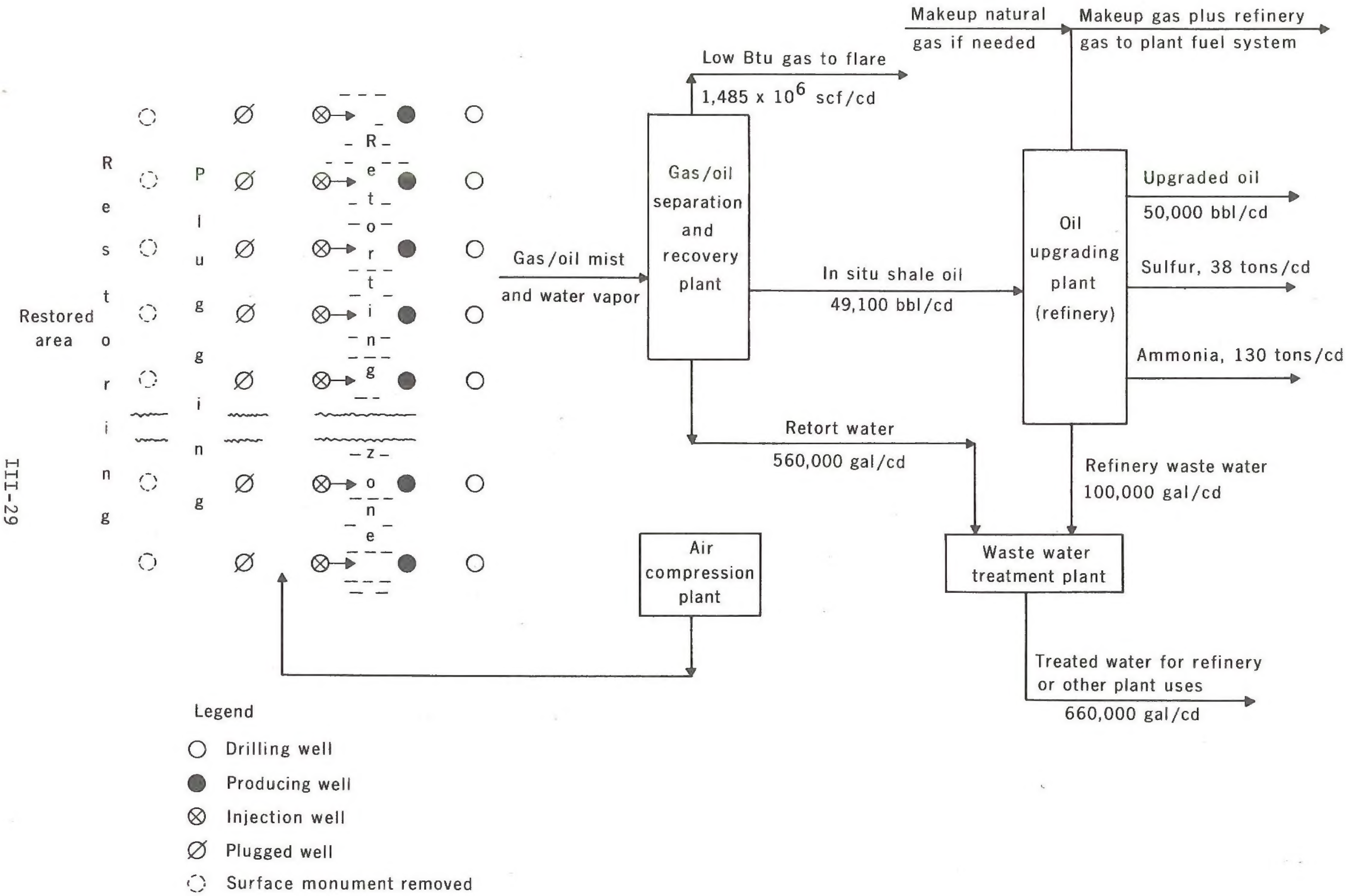


FIGURE III-10.- Flow Diagram of 50,000-Barrel-Per-Calendar-Day In Situ Recovery System

(1) Insufficient naturally occurring permeability, or failure to artificially induce sufficient permeability to allow effective heat transfer and passage of gases and liquids; and

(2) Inability to remotely control the process with sufficient accuracy through wellbores from the surface.

Besides surface wellbores, other methods proposed for inducing heat underground include mine shafts, tunnels, and fractures created by a variety of techniques.

A commercial in situ processing system has not yet been demonstrated. Additional field-scale operations are needed since it is quite difficult to design meaningful laboratory-scale experiments. Such field tests can be conducted on the six selected lease sites.

C. Personnel Requirements

The number of shale industry employees for a given tract is determined by the processing system used and the level of production. For the three processing systems previously mentioned, it is believed that the following sequences of direct industry employment will apply.

1. Underground Mining and Surface Processing (50,000-Barrels-per-Day Production)

During the first 3 years of application of this system on a given tract an estimated 200 employees would be required for pre-commercial field investigations and process design. The commercial construction and development period, lasting about 36 months, would require an average of about 1,500 employees. At steady state, full-scale, commercial operation, an estimated 1,300 permanent employees of all types would be needed.

2. Surface Mining and Surface Processing (100,000 Barrels-per-Day Production)

During the initial 3 year term of a surface mining operation on a lease, about 200 employees would be required for preconstruction field studies and design. The commercial construction and development period, which would extend thirty-six months, would involve an average of about 2,400 employees. Approximately 2,200 permanent employees will be required if and when steady state commercial operation is finally attained.

3. In Situ Processing (50,000-Barrels-per-Day Production)

For the first year of the lease, an estimated 100 employees would be required for field investigations and process design. During the construction period, lasting approximately 36 months, employment would average about 1,200 employees. If commercial operation is attained, employment would approximate 1,400 employees.

IV. ENVIRONMENTAL IMPACT OF PROPOSED ACTION

The leasing of six prototype tracts for oil shale development on public lands would produce both direct and indirect changes in the environment. Impacts include those on the land itself, water resources, air quality, fish and wildlife, grazing, esthetics, recreation, and cultural values, and the existing social and economic environment.

A regional assessment of these possible impacts for a 1-million barrel per day industry is presented in Volume I, Chapter III. Pertinent information presented in Volume I is incorporated below by reference as appropriate.

The estimates given in this Chapter are for a 30-year period over which nearly all of the high grade resource will be exhausted from a 5,000 acre tract that employs underground mine development. However, as technology advances, an oil shale complex at full-scale production may extract recoverable reserves in greater quantity than anticipated in developing these data for the lease tracts. In this case, development at a single surface mine, for example, may be possible for periods of up to 50 to 70 years and the impact, therefore, would be proportionately greater than the impact considered in this analysis, but probably of some ratio less than 1:1.

A. Land Impacts

Major impacts on the land itself as a result of the proposed leasing program, are concerned with the amount and kinds of surface disturbances. Effects on soils, vegetation, topography, and specific land and cultural features are considered in this section. Related effects on wildlife habitat, grazing patterns, water quality and recreation are described in subsequent sections of this chapter.

Changes in the land surface have been assessed over the 20-year lease period provided under the prototype leasing program. In most cases, this would include 5 years of pre-production activity, and 15 years of actual, full-scale production. An estimate is also made for the changes involved over a 30-year period.

It is estimated that the six tracts would require 8,000 to 11,000 acres of land surface, both on-site and off-site for construction of mines, excavations, plant facilities, storage areas, and processed shale disposal areas. An additional 1,700 to 2,000 acres would be altered, in part permanently, in construction of roads, utility corridors for power, natural gas, water and shale oil product lines. A maximum of approximately 13,000 acres would be required overall for prototype development, less than 0.1 percent of the oil shale land surface area in the States of Colorado, Utah, and Wyoming.

The development of each of the six selected tracts is examined with respect to applicable processing options. Included in this evaluation are the mining, rates of productions of oil and process wastes, methods of waste disposal, services and roads required and their location, and land surface areas which might be used. These are the essential technical parameters which describe the on-site and related off-site activities that could be expected on each tract.

Common to each of the tracts is the need for oil storage, pipelines, transmission lines, and access roads as set forth in Table IV-1. Their effects on the environment, as determined by their size, length, and probable route, have been included in the analysis given below for each prototype tract.

As indicated in Table IV-1, access to Tract C-a would require widening and improving some 15 to 16 miles of present unpaved road

TABLE IV-1.--Summary of Utilities and Facilities for Six Prototype Tracts

Area	Tract	Power	Natural Gas	Water	Oil Pipeline	Storage	Roads
Colorado	C-a 100,000 B/CD surface mine	100 megawatts generated on site or obtained 3 miles SW at Stake Springs Draw	18 inch pipeline extension 1 mile away	From 16.5-25.5 cfs from in-place ground water or from an 18 mile long pipeline to the White River or from a combination of ground and surface water sources	A 30 mile, 18 inch pipeline to existing line at Rangely	Steel vessels 80 acre requirement	Rifle, Colorado would probably serve as the railhead. Access to the site will be from the Piceance Creek road to Ryan Gulch; thence south and west some 7 miles on the Ryan Gulch road; then north and west to the 84 ranch; and from this point, west to the mine site. Widening, paving and straightening of some 15 or 16 miles of the road will be required. Another route may be developed from the Douglas Creek road, which would provide more direct access to Grand Junction and Rangely, or alternatively, along the possible water pipeline route some 18 miles north to Highway 64 and then to Rangely.
	C-b 50,000 B/CD underground mine	50 megawatts generated on site or obtained from existing power about 1 mile away.	12 inch pipeline construction 2-3 miles to existing line along Piceance Creek	From 8-13 cfs from in-place ground water or from a 25 mile long pipeline to the White River from storage diverted to Piceance Creek or from a combination of ground and surface water sources	A 40 mile, 12 inch pipeline to Rangely	Steel vessels 40 acre requirement	Ingress to the tract from the Piceance Creek road is currently blocked by patented lands along the creek bottom, but BLM is attempting to secure entry permission via Scandard Gulch. Access is therefore assumed via this road, which must be widened and paved. In addition, a heavy duty bridge will be required across Piceance Creek.

TABLE IV-1.--Summary of Utilities and Facilities for Six Prototype Tracts (Continued)

Area	Tract	Power	Natural Gas	Water	Oil Pipeline	Storage	Roads
Utah	U-a and U-b, 50,000 B/CD underground	50 megawatts generated on site or obtained from Jensen about 35 miles to the north	12 inch pipeline construction 15 miles to Bonanza, Utah	From 8-13 cfs construction of a 10 mile, 16 inch pipeline to the White River	6 miles construction north of the tract, 12 inch pipeline	Steel vessels 40 acre requirement	There is a paved state highway to Bonanza. From there it will be necessary to build eight miles of primary roads and a bridge across the White River.
Wyoming	W-a and W-b, 50,000 B/CD in situ	50 megawatts generated on site or obtained from near Rock Springs 40 miles to the north	12 inch pipeline construction to existing 20 inch pipeline approximately 10 miles south of tracts	From 3-6.5 cfs construction of 50 mile, 10 inch pipeline west to either the Flaming Gorge Reservoir or the Fontonelle Reservoir	Construction of 35 mile, 12 inch pipeline, northeast to Patrick Draw Oil field	Steel vessels 40 acre requirement	Access to the tracts would involve improvement of 42 miles of road connecting to either Interstate Highway 80 to the north, or of 14 miles of road to Wyoming State Highway No. 430 to the west.

from the Piceance Creek Highway, or Highway 64 along the White River to the north, or construction of new road to Douglas Creek to the west. Utility corridors would probably include a 30-mile oil pipeline to Rangley, Colorado, although other pipeline ties are possible. Water, if needed, could be obtained via an 18-mile pipeline from the White River due north of the tract. Power, if not generated on-site, may be obtained 3 miles southwest of the tract at Stake Springs Draw and a natural gas pipeline is located in the same direction about 1 mile away. The land required for access and utility corridors would range from 200 to 600 acres of surface.

A surfaced highway exists along Piceance Creek adjacent to Tract C-b. Off-tract road development can therefore be limited to a 2 to 3 mile long connecting link from the tract to the highway. A 40-mile oil pipeline might be constructed to Rangley. Surface water, if needed, could be obtained from the White River system via a pipeline or through canals to the upper reaches of Piceance Creek. Power, as an alternative to on-site generation, is available 1 mile away from the tract, and natural gas is available 2 to 3 miles away. Access and utility corridors would require approximately 200 to 600 acres of surface.

For the two Utah tracts, access could be gained by an 8-mile extension of a paved state highway at Bonanza. Water would be obtained probably using a 10-mile pipeline north to the White River. An oil product pipeline would need to be constructed to a pipeline located 6 miles north of these sites. Natural gas is available 15 miles north at Bonanza, and power, as an alternative to on-site generation, could be available from Jensen, about 35 miles to the north. A total of 200 to 600 acres would be required.

Access to Wyoming Tracts W-a and W-b would involve improvement of about 42 miles of road, to connect the prototype lease sites with Interstate 80 to the north, or about 14 miles of a now seasonal road which connects with Wyoming No. 430 to the west. A connecting oil product pipeline 35 miles long would probably be required to tie in with a transcontinental line located north of the tract. A power transmission line will probably be required, with a tie likely to the Jim Bridger plant (Pacific Power and Light) 40 miles to the north, near Rock Springs, Wyoming. A natural gas pipeline is located approximately 10 miles south of the tracts which connects with other gas lines near Rock Springs. Water requirements would probably be met through a pipeline diversion from Flaming Gorge Reservoir, approximately 50 miles to the west. The land surface required from these activities would approximate 600 acres.

1. Land Requirements, Tracts W-a and W-b

Two adjacent tracts, W-a and W-b, have been selected for leasing in Wyoming. Only 1 technical option, in situ recovery, has been considered for the extraction of shale oil from these tracts because of the nature of the shale resources available. No specific environmental differences between tracts were discovered during field investigations; therefore, the tract impacts have been considered together throughout this chapter.

In situ processing involves heating oil shale in its underground location, thus avoiding the need for mining. Various means of supplying or creating heat that have been tried or proposed include

underground combustion, injection of heated natural gas, carbon dioxide gas, superheated steam, or hot solvents, and combinations of the above.

Because of the relatively uncertain status of in situ oil shale technology as compared to above ground retorting technology, it is expected that a longer period of development time will be required before commercial-level, in situ production can be shown to be feasible and production attained. However, the concept is well enough established to permit general assessments of the land required for in situ processing. This is detailed below for the Wyoming tracts and is summarized for those in Colorado and Utah. In all cases, production of 50,000 barrels of upgraded shale oil per day is assumed. For Tracts W-a and W-b, this would probably not be until the 6th year of the leases. Land surface required for surface facilities is about 50 acres.

To illustrate the dynamic nature of in situ processing, it is estimated that the two Wyoming tracts would require multiple rows of 100 wells which would be drilled on a monthly basis (Figure IV-1). Five rows of wells would comprise various phases of the active project with ongoing activities including the retorting itself, preparations for the next series of wells, and restoration. This active area would cover 115 acres and would progressively more forward as new wells were drilled and old ones plugged prior to removing the surface monuments for purposes of restoration. It would take about 3 years to fully restore the area; therefore 835 acres would be in some phases of restoration while 115 acres would have active drilling, plugging,

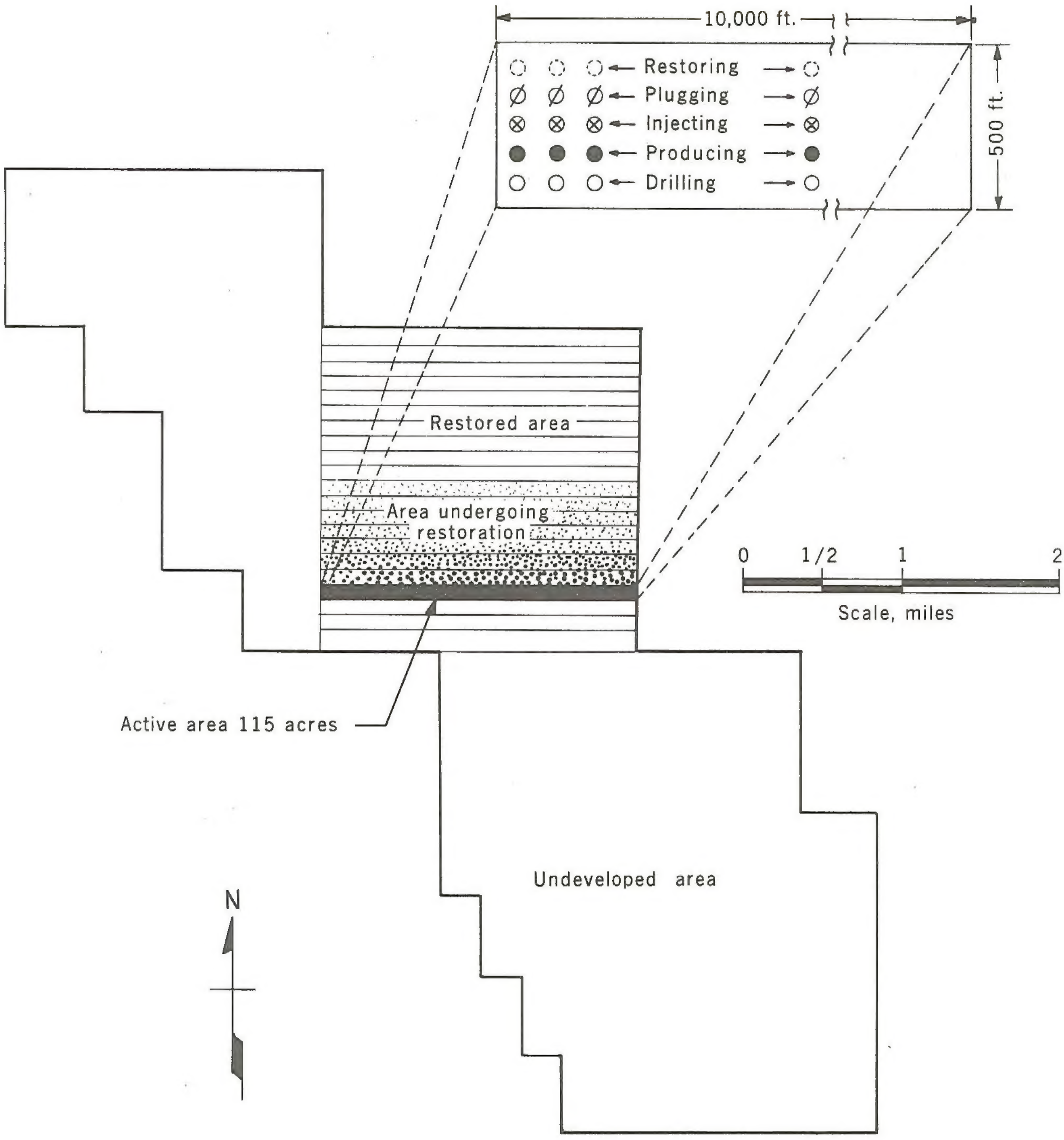


FIGURE IV-1.--Wyoming Tracts Wa and Wb In Situ Recovery, Conceptual Development Approach

etc., in progress. The cumulative disturbed land is shown in Table IV-2. At the end of 20 years, this would include 600 acres for access roads and utilities, 50 acres for surface facilities, 115 acres for well activities, and 835 acres undergoing restoration. The surface area required for utility corridors and roads (600 acres) is larger than for any of the tracts in Colorado and Utah because the Wyoming tracts are greater distances from existing facilities.

Table IV-2.--Land Requirements for Tracts W-a and W-b.

Years	Acres
5	300
10	1,600
20	1,600
30	1,600

Subsidence due to in situ processing could cause changes in drainage patterns. However, subsidence has not been observed in experimental tests conducted to date. For example, pilot tests are currently being conducted by the U.S. Bureau of Mines at a location about 40 miles to the northwest of Tracts W-a and W-b. A 50-week test during 1970 provided the opportunity to observe elevation effects due to explosive fracturing and retorting the oil shale in-place. Explosive fracturing at Rock Springs, using up to two

300-quart charges of nitroglycerin, resulted in increasing the surface elevation by as much as 2 1/2 inches. Extensive core drilling following the underground retorting experiment indicated that the oil shale was successfully retorted in-place and that voids in the oil shale were small. Since large void spaces were not detected, this suggests that subsidence may not occur. This was later confirmed since, to date, no evidence of surface subsidence has been noted following the experiment.

2. Land Requirements, Tract C-a

Three technical options are considered below for extraction of shale oil from this tract. Based upon available technology, these are underground mining and surface processings, surface mining and surface processing, and in situ processing. The cumulative land requirements for these options are presented in Table IV-3, and are separately discussed below.

a. Land Requirements for Underground Mining and Surface Processing

The pertinent technical parameters used in Chapter III to assess the impact for this method of shale processing are a production rate of 50,000 barrels per day of shale oil (after the 5th year of the lease) requiring mining of 73,700 tons per day of raw shale based on an average grade of 30 gallons per ton. This level of operations would require disposal of about 60,000 tons per day of retorted shale. An area of 140 acres would be required for the plant.

TABLE IV-3.--Land Requirements for Tract C-a.
(Acres)

Requirements	Years			
	5	10	20	30
Surface Mining:				
Surface disposal:				
With restoration	2,400	2,700	3,300	3,400
Cumulative land disturbed	2,450	3,200	5,000	6,650
Canyons 1/	-	D	C-E	A-F
Surface disposal with back-fill				
With restoration	2,450	2,700	3,300	2,700
Cumulative land disturbed	2,450	3,200	4,300	4,600
Canyons	-	D	C-F	C-F
Underground Mining:				
Surface disposal:				
With restoration	350	700	850	1,110
Cumulative land disturbed	350	700	1,450	2,210
Canyons	-	B	B-C	B-D
Underground disposal (60%):				
Cumulative land disturbed	350	600	800	1,090
Canyons 1/	-	D	D	D
In situ: With restoration	300	775	775	775

1/ See Figures IV-2 and IV-4 and related text.

Two options have been considered for processed shale disposal:

(1) Surface disposal off-site in canyons 8 miles west of Tract C-a; 73 acres of land area are required each year. A possible area delineated for this disposal is shown in Figure IV-2. Assuming a 30-year underground mine development, the area designated B, C, and D could be used for processed shale disposal.

(2) The second option is disposal of 60 percent of the material in mined out areas underground and 40 percent on the surface. During the first three years of production, all processed shale would be disposed on the surface off-site, 8 miles west of Tract C-a, after which sufficient underground space would be available for partial disposal. Two hundred and twenty acres of land area are required for the first 3 years, plus 30 acres per year thereafter. In Figure IV-2, the off-site area required is shown as canyon D, for a 30-year mine development.

The impact of this activity on the topography is shown in Figure IV-3, which is a cross section drawn through the canyons. Canyons B, C, and D would be filled to a depth of about 250 feet should they be utilized for processed shale disposal. It should be emphasized that the particular canyons delineated might or might not be used. They were only chosen to depict the surface area requirements necessary for spent shale disposal. However, should they be used, some 10,000 linear feet of State Bridge Draw and 9,200 linear feet of Right Fork of East Fourmile Draw, would be needed for the all-surface-disposal option over a 20-year period. In a 30-year operation, 12,400 feet of Vandamore Draw, 10,000 feet of State

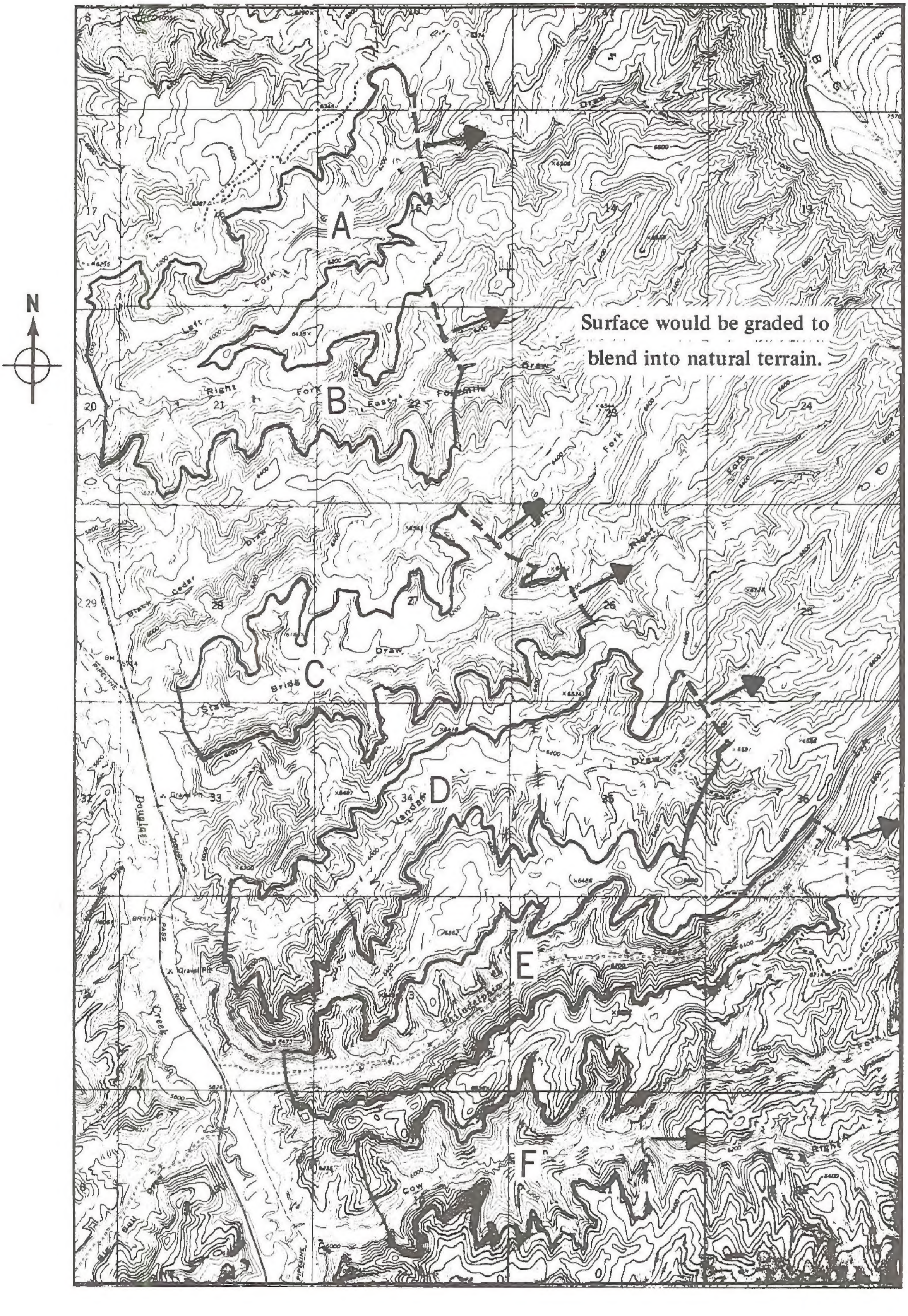


FIGURE IV-2.--Possible Area for Spent Shale Disposal, Tract C-a.

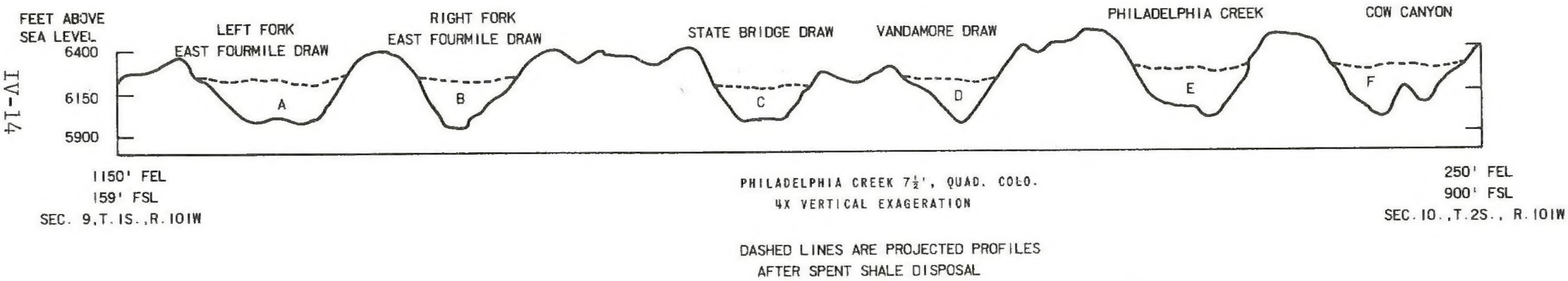


FIGURE IV-3.--Cross Section of Possible Disposal Area for Tract C-a.

Bridge Draw, and 10,000 feet of the Right Fork of East Fourmile Draw, would be required. If 60 percent of the processed shale is returned underground, 7,800 linear feet of State Bridge Draw will be required in a 20-year operation, and 12,900 linear feet of Vandamore Draw will be required for disposal in a 30-year operation.

b. Land Requirements for Surface Mining and Surface Processing

This method would involve the excavation and disposal of overburden, mining of the oil shale and associated minerals, processing, disposal of processed shale, disposal of any excess ground water produced in the open pit, and restoration of the mined-out areas. The pertinent technical parameters assumed to be applicable to Tract C-a for this development method include production of 100,000 barrels per day of shale oil (after 5th year of lease) which would require mining 147,000 tons per day of raw shale (30 gallons per ton). At this scale operation, disposal of about 118,000 tons per day of retorted shale would be required. Land area required includes 150 acres of facilities plus 40 to 85 acres per year for mine development.

Overburden from the operation is assumed to be stacked on the surface off-site, west of the tract. Figure IV-4 illustrates an area that could be utilized. Overburden disposal could continue until the open pit operation had reached a stage at which all or part of the new overburden mined could be disposed of in the pit floor. For purposes of illustration, this was assumed to occur after 16 years of full-scale production. The overburden, 256 million cubic yards, would cover an area of 980 acres and would be disposed of at a rate of 30 to 65 acres per year. An illustration of the impact of this operation on the topography is shown in Figure IV-5.

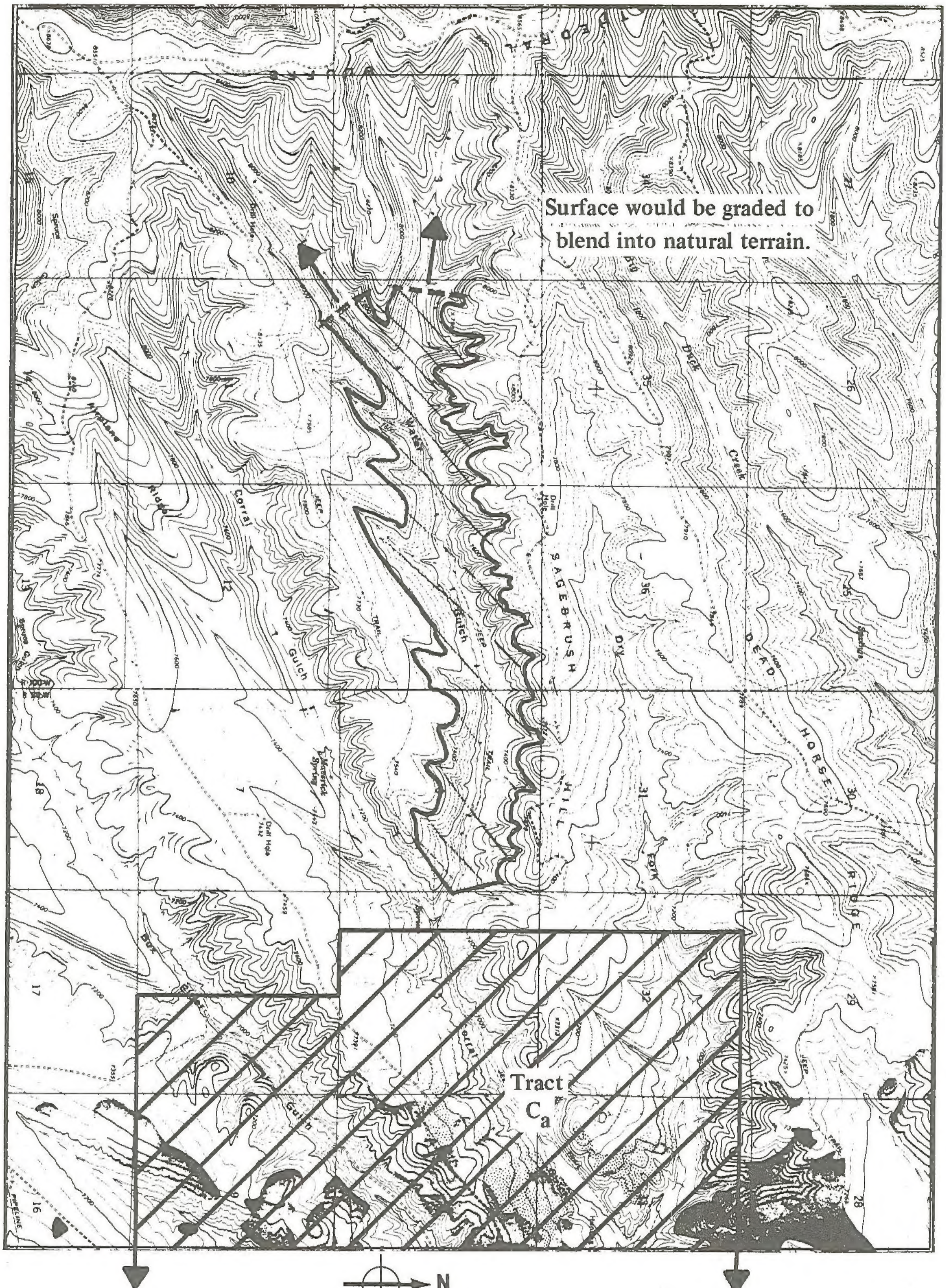


FIGURE IV-4.--Possible Area for Overburden Disposal Tract C-a.

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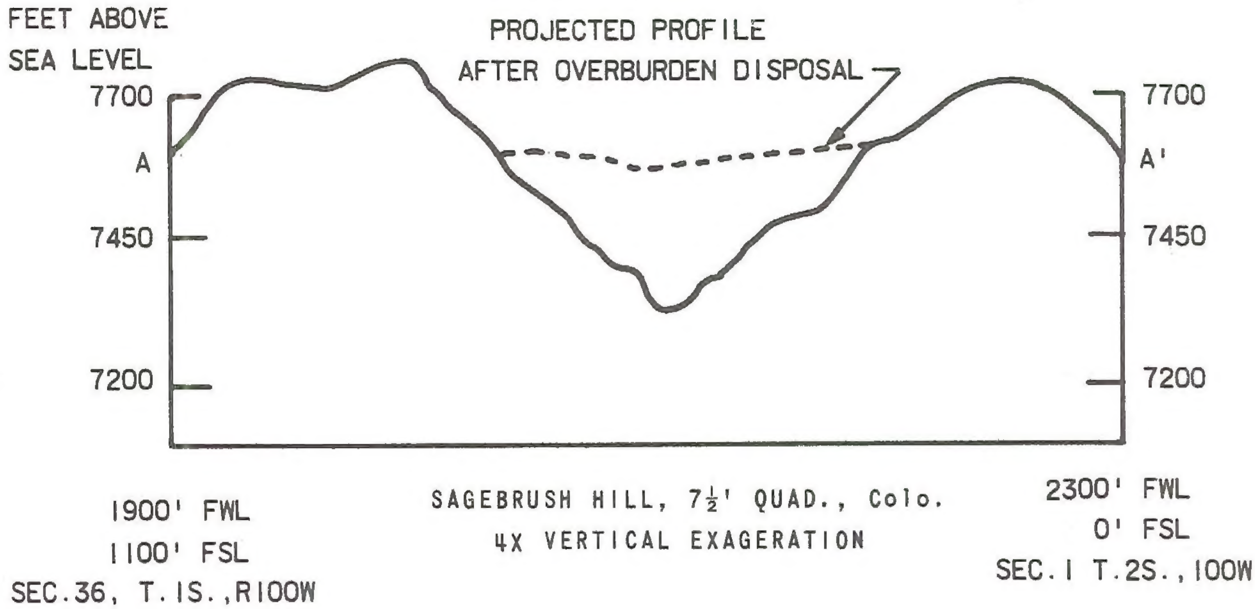

FIGURE IV-5.--Cross Section of Canyon Fill for Overburden Disposal, Water Gulch.

If the overburden were disposed of in Water Gulch, a total of 17,000 linear feet would be needed. This area would no longer be needed for overburden disposal in the latter years of the lease, if overburden were returned directly to the pit.

Two options have been considered for the disposal of processed oil shale:

(1) Disposal off-site, in canyons west of Cathedral Bluffs, which require 140 acres per year; and

(2) Disposal off-site, as above, until material can be backfilled into mined out areas of the pit. Figures IV-2 and IV-4 illustrate those areas that would be large enough to contain the spent shale should this form of mining be selected.

If the processed shale were permanently placed in the dry canyons immediately west of the Cathedral Bluffs, on land devoid of oil shale, some 2,200 acres of canyon land would be used. About 14,000 linear feet of Vandamore Draw, 16,000 linear feet of Philadelphia Creek, and 8,700 linear feet of State Bridge Draw would be permanently altered in appearance (Figure IV-2). Over the first 20 years, a total acreage of about 5,000 acres would be needed both on- and off-site.

Processed shale from a 30-year operation would require an additional 1,650 acres or 6,650 total acres. The canyons described above could be utilized plus 10,000 linear feet of Left Fork East Fourmile Draw, 10,000 linear feet of Right Fork East Fourmile Draw, an additional 1,300 linear feet of State Bridge Draw, and 7,500 linear feet of Cow Canyon. An alternative mode of operation might be to return the spent shale to the floor of the surface mine after

the pit opening was large enough to permit return as backfill (about 16 years). In this case, approximately 1,800 acres of canyon lands off-site would be permanently filled, contoured, and revegetated. This disposal method would require 10,000 linear feet of Vandamore Draw, and 7,500 feet of Cow Canyon. Total land required using this mining option would include the 1,800 acres described above, 400 acres off-site, 200 acres for plant area, 1,200 acres for the surface mine, and 1,000 acres for overburden disposal for a total of 4,600 acres.

c. Land Requirements for In Situ Processing

In situ processing would involve surface injection and extraction wells along lines previously described for the Wyoming tracts, except that the well pattern and surface areas would differ. For an assumed production rate of 50,000 barrels per day of shale oil (probably not until at least 6th year of the lease), surface facilities would require 45 acres; an additional 15 acres would be active due to well drilling and completion work and areas previously active will be going through various phases of restoration. Tract C-a has a much thicker zone of oil shale (450 feet); thus the surface area requirements would be considerably less than those for Wyoming. While the probability of subsidence is greater than discussed for Tracts W-a and W-b above, significant displacement is not expected.

Whatever processing method were employed on this tract, some 175 to 225 acres of surface, most of which would be off-site, would be required to create utility corridors and roads.

3. Land Requirements, Tract C-b

This is the second tract selected in Colorado for possible leasing. Available technical information and the most likely methods for mining, processing, and waste disposal for this tract are described below. Two technical options are considered for extraction of shale oil from this tract. Based on current technology, these are:

(1) Underground mining and surface processing, and

(2) In situ processing by surface well extraction.

Cumulative land requirements for these two options are shown in Table IV -4, and are discussed below.

TABLE IV-4.--Land Requirements for Tract C-b
(acres)

	Years			
	5	10	20	30
Underground:				
Surface disposal:				
With restoration	350	700	850	1,110
Cumulative land disturbed	350	700	1,450	2,210
Canyons	-	A	A-B	A-C
Underground disposal (60 percent)	350	600	800	1,090
Canyon	-	A	A	A
In situ:	300	790	790	790

a. <u>Land Requirements for Underground Mining and Surface Processing</u>

On the basis of current technology, underground mining and surface processing appears to be the most feasible processing system for Tract C-b. Surface mining is not considered to be economic because of the high overburden to ore ratio of the deposits on the tract. The key technical parameters used to estimate the impact of development were 50,000 barrels per day of shale oil (after 5th year of lease) which would require mining and processing 73,700 tons per day of raw shale (average 30 gallons per ton) and disposal of about 60,000 tons per day of processed shale. The land surface area required for plant facilities would total 140 acres. Two options were considered for processed shale disposal as is shown in Table IV-4 and Figure IV-6:

(1) For surface disposal partially on-site, the land required would total 73 acres per year in the areas delineated in Figure IV-6; and

(2) Disposal of 60 percent in mined out areas underground, 40 percent on the surface.

During the first 3 years of production, all processed shale would be disposed on surface until sufficient underground surface was available. The surface land requirements would be 220 acres during the first 3 years and 30 acres per year thereafter. The impact of disposal on the topography of the area is given in a cross section through the described canyons before and after disposal as shown in Figure IV-7.

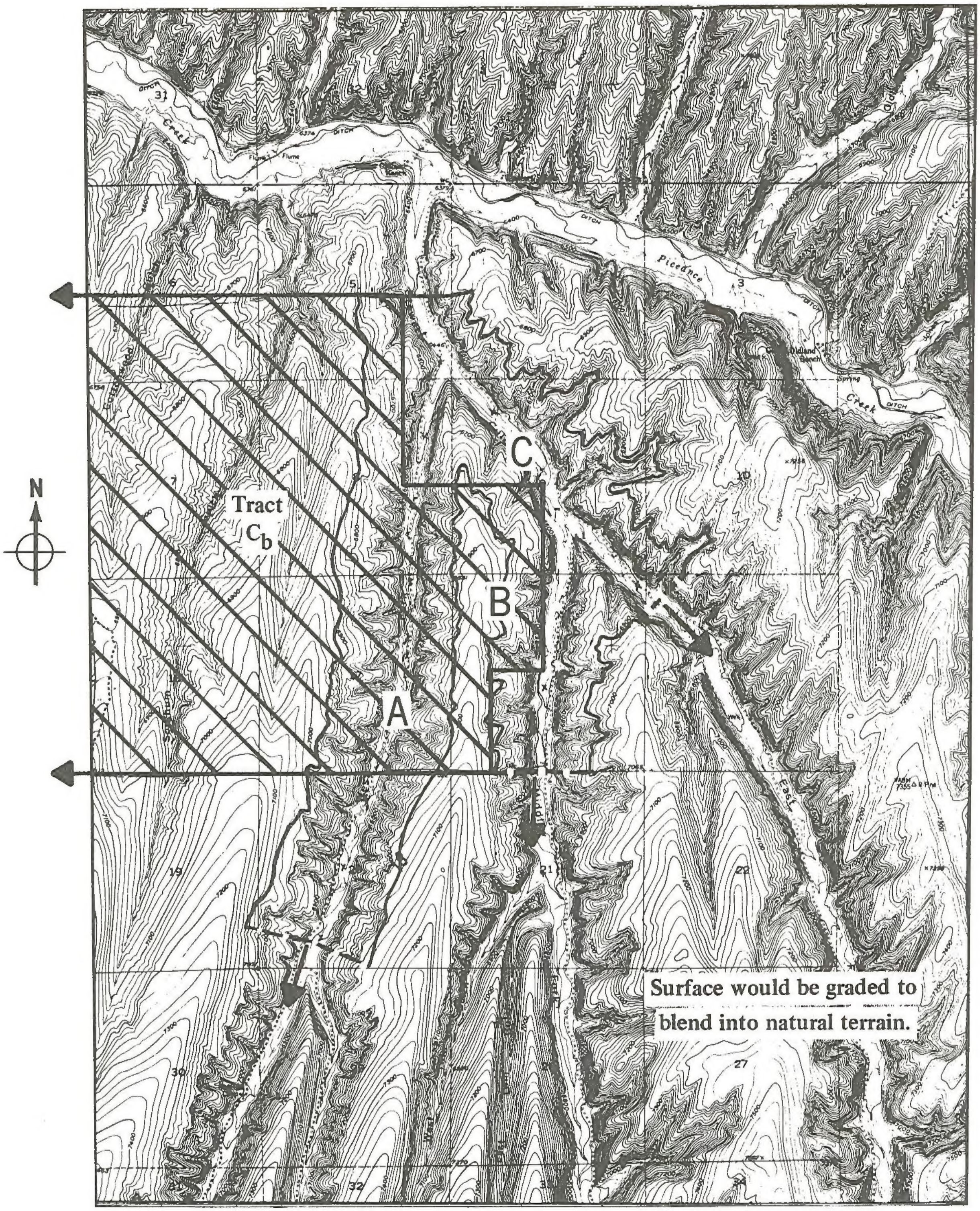

FIGURE IV-6.--Possible Area for Spent Shale Disposal, Tract C-b.

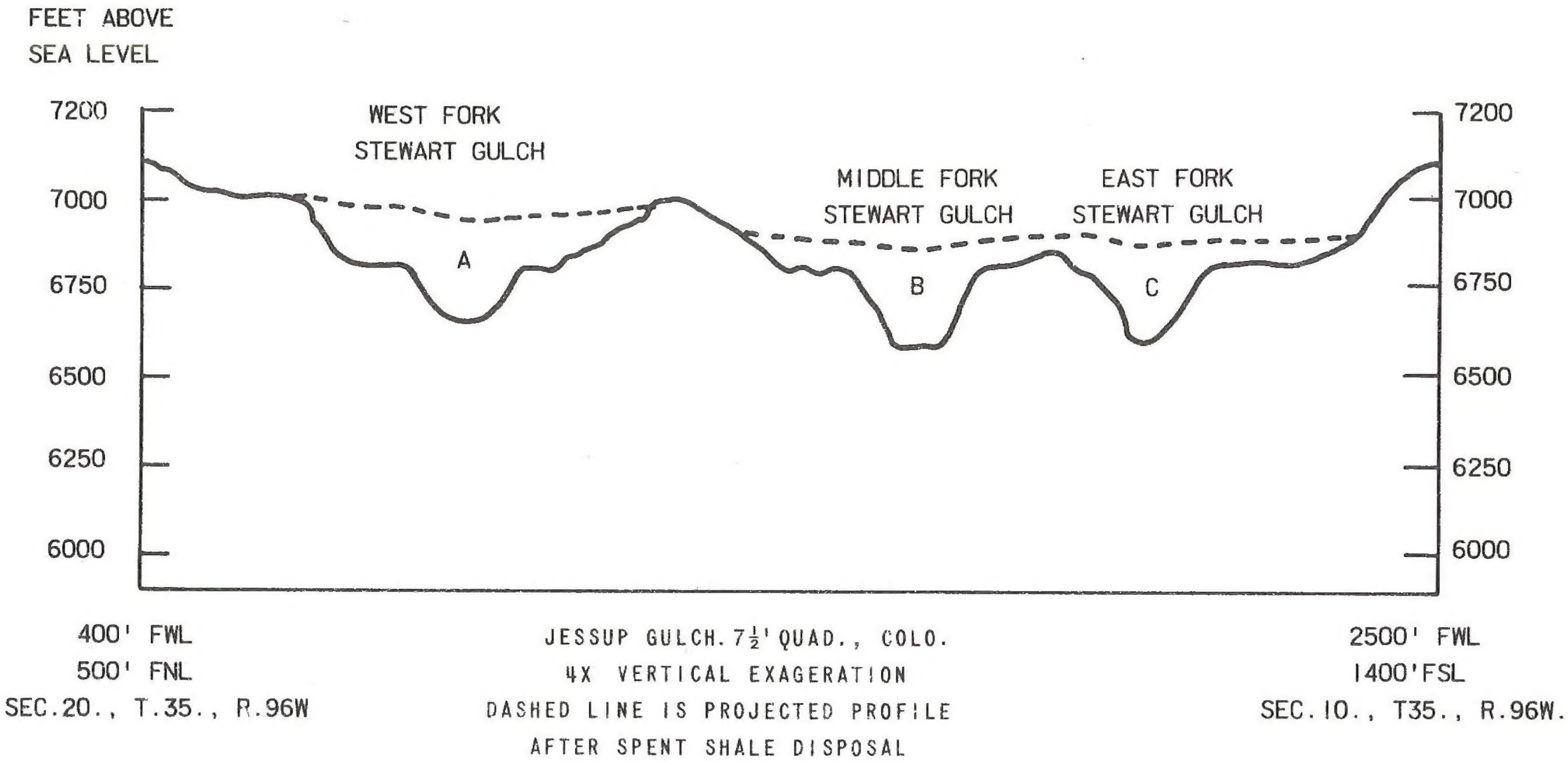

FIGURE IV-7.--Cross Section for Possible Area for Disposing of Spent Shale.

Over a 20-year period, processed shale would require 1,100 acres for total surface disposal on-site and near-site. For this study, some 19,200 feet of the West and Middle Forks of Stewart Gulch were considered for that purpose. Alternatively, 450 acres on-site would be required if 60 percent of the waste were to be returned underground to the mine after the third year of operation.

In a 30-year operation with total processed shale disposal on the surface, 32,400 linear feet of West, Middle, and East Fork of Stewart Gulch would be required. Requirements would decrease to 12,900 linear feet of the West Fork of Stewart Gulch if 60 percent were backfilled to the mine. If the lower zone shales were eventually mined and the accompanying saline minerals recovered in substantial quantities, it is possible that all of the processed shale could eventually be returned underground as mine backfill, with no permanent need for surface disposal.

Approximately 170 to 200 acres of surface, most of which would be off-site, would be used in construction of utility corridors and roads.

b. Land Requirements for In Situ Processing

The pertinent technical parameters assumed for in situ processing on Tract C-b included a production rate of 50,000 barrels per day of shale oil not to be attained until at least the 6th year of the lease. The active well area and restoration area will be similar to that given for Tract C-a. In this case, 15 wells will have to be drilled each month as the underground retorting continues to move.

In situ processing of shale on Tract C-b would produce less surface alteration than on any of the other in situ tracts. Beyond the 50 acres of surface occupied by above ground processing facilities at any one time, 140 acres would be needed for the well drilling, producing, and restoration cycle, as detailed earlier for the Wyoming tracts earlier.

If either underground mining or in situ processing were carried out on Tract C-b, some surface subsidence might eventually occur. The possible effects of subsidence include surface displacement (presently of unknown magnitude, but possibly in the order of tens of feet), interference with aquifer water movement, and changes in surface drainage patterns. However, subsidence, if it occurs at all, would probably not occur until years after operations have ceased. In the case of underground mining, return of processed shale to the mine as backfill would be expected to minimize the danger of such subsidence.

4. Land Requirements, Tracts U-a and U-b

Two tracts, U-a and U-b, have been chosen for leasing in Utah. These tracts are adjacent, and no significant environmental differences were discovered during field investigations; consequently, their environmental impacts have been considered together. Two technical options are considered for extraction of oil shale from these tracts:

(1) Underground mining and surface processing; and

(2) In situ processing with surface well extraction.

Surface (open pit) mining is not considered to be economic on either tract because of the high overburden/ore ratio of the deposits on both tracts (5.6/1 to 14.0/1 on U-a, and up to 7.0/1 on U-b). The cumulative land requirements are illustrated in Table IV-5 and discussed below.

TABLE IV-5.--Land Requirements for Tracts U-a and U-b
(acres)

Requirements	Years			
	5	10	20	30
Underground:				
Surface disposal:				
Cumulative land disturbed	350	700	1,450	2,210
Canyon	A	A	A	A
Underground disposal (60 percent):				
Cumulative land disturbed	350	600	800	1,090
Canyon	A	A	A	A
In situ	300	1,790	1,790	1,790

a. <u>Land Requirements for Underground Mining and Surface Processing</u>

The pertinent technical parameters for underground mining and processing of Sites U-a and U-b are summarized below for a combined production of 50,000 barrels per day from the tracts (after 5th year of lease). To supply the raw material for this scale of operations, 73,700 tons per day of raw shale would be mined (average 30 gallons per ton) and about 60,000 tons of processed shale would be disposed of each day. Land surface required for plant facilities would total 140 acres.

Two options are considered for processed shale disposal;

(1) Surface disposal involving both on-site and adjacent land, assuming a dump 250 feet high. Land area required for this operation would equal 73 acres per year.

(2) The second option is disposal of 60 percent in mined-out areas underground and 40 percent on surface. For this first three years of production, until sufficient underground space is created, all disposal would be on surface. Land area required would total 220 acres over the first three years, plus 30 acres per year thereafter.

As shown in Figure IV-8, a possible disposal site is located on and south of Tract U-b. This area is suggested in order to illustrate the acreage requirement; however, it is not intended to be the only choice for disposal purposes. In the assumed case, the canyon width averages about 4,000 feet. If the spent shale was piled to a depth of 250 feet, the terrain after disposal would be similar to that shown by the cross section in Figure IV-9.

In a 20-year oil shale operation, processed shale would require 1,100 acres for total surface disposal on and near the site, disturbing 15,600 linear feet of Evacuation Creek. About 450 on-site acres would be required, if 60 percent of the waste were to be returned underground to the mine and 6,300 linear feet of Evacuation Creek would be required. In a 30-year operation with total surface disposal, 25,800 linear feet

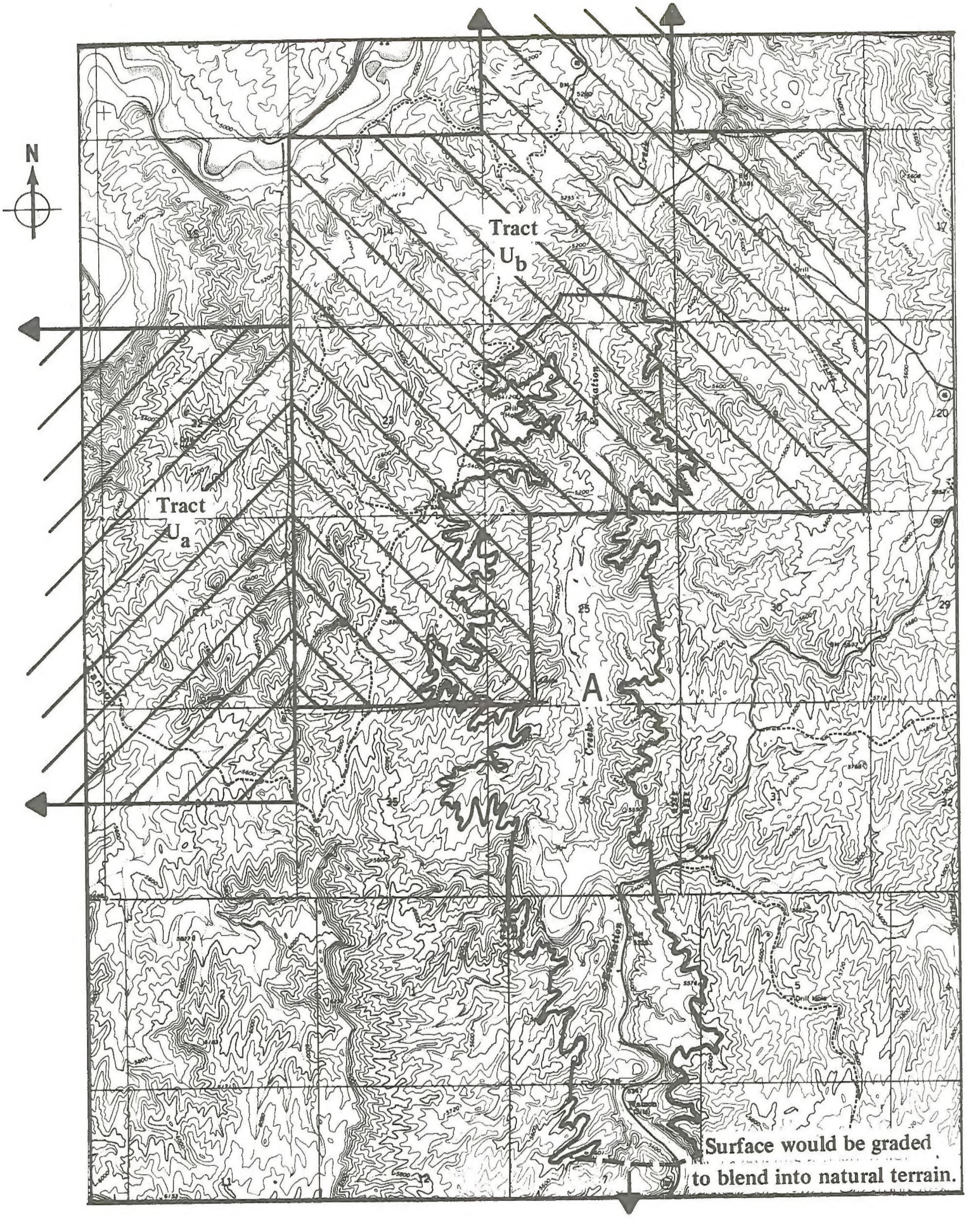

FIGURE IV-8.--Possible Area for Spent Shale Disposal, Tract U-b.

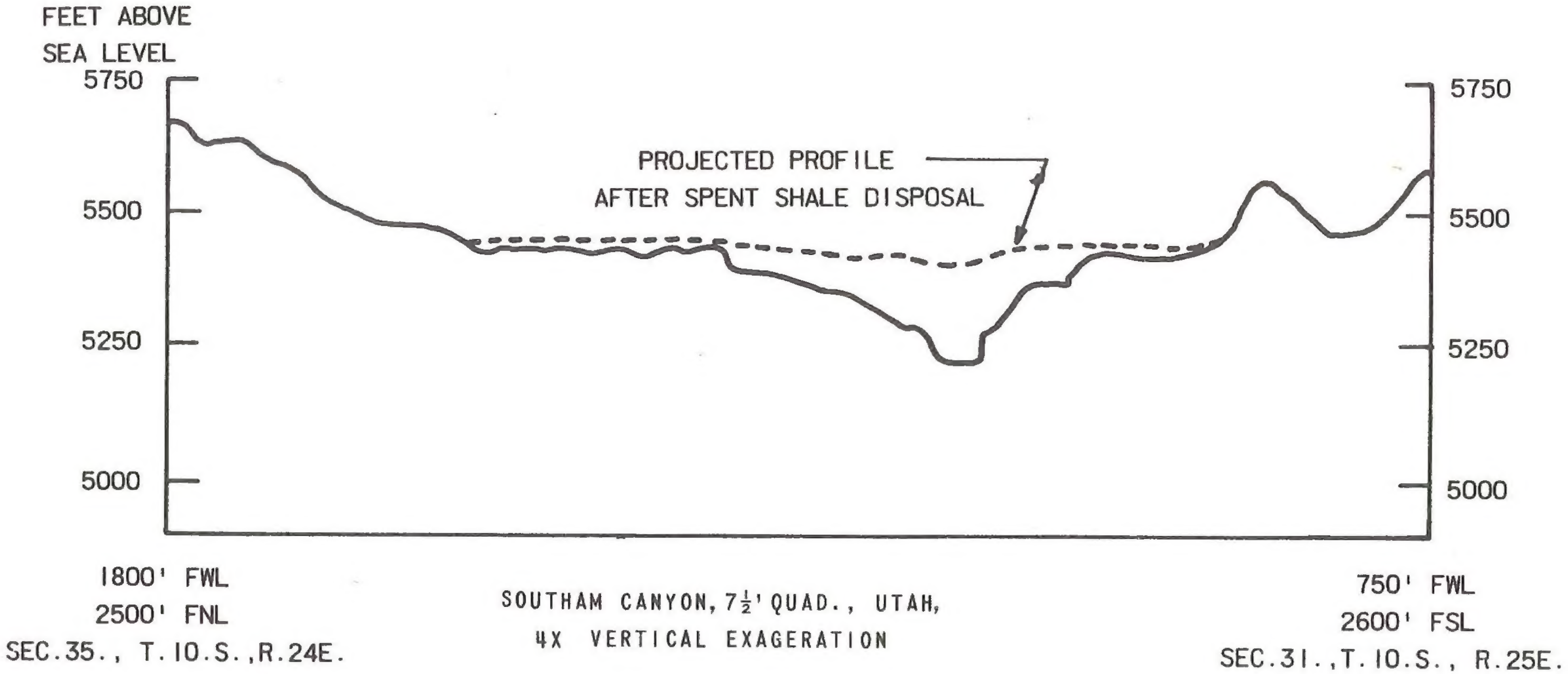

FIGURE IV-9.--Cross Section for Spent Shale Disposal Tract U-a and U-b, Evacuation Creek.

of Evacuation Creek would be covered. If 60 percent of the waste were to be returned underground to the mine, only about 10,500 linear feet of Evacuation Creek would be needed.

Approximately 180 to 200 acres of surface, most of which would be off-site (See Volume II, Chapter III) would be required for utility corridors and roads.

b. <u>Land Requirements for In Situ Processing</u>

The pertinent technical parameters assumed for this method of shale processing are 50,000 barrels per day of shale oil (probably not until at least the 6th year of the lease). The land surface area required for facilities is estimated to be 50 acres. With oil shale resources thickness of 45 feet on Tract U-a, and 50 feet on Tract U-b, drilling of about 120 wells will be required each month to recover 50,000 barrels of oil per day. A large number of these wells could be drilled prior to actually starting the in situ processing operation.

About 1,140 acres would be active with either some phase of well completion, operation, or restoration work. Once the surface area of the tract was restored, this area would be similar to that prior to underground retorting. Damage to the ground surface in the active well area would be caused by drilling pads, moving equipment in and out, and generally trampling the area around the active injection and producing well.

If either underground or in situ mining is carried out on Tracts U-a and U-b, surface subsidence might occur. In the case of underground mining, return of processed shale to the mine as backfill would be expected to eliminate the possible effect of subsidence as described previously for Colorado Tract C-b.

5. Impact on Vegetation

Projected vegetation impacts associated with construction and operation of surface facilities, mining activities, overburden, and processed shale disposal, and development of utility corridors will vary considerably from tract to tract depending upon the development options considered. The physical characteristics of the individual tracts will also determine impacts.

Existing vegetation will be essentially eliminated from all land surface allocated to surface facilities, overburden storage, stockpiling, borrow areas, and waste disposal. Mining activities and waste disposal associated with underground mines will destroy the vegetation on small areas around the mine openings.

Vegetation changes will take place on the entire surface area involved in in situ shale oil extraction activities. Existing vegetation will be eliminated from drill pad sites and the vegetation on the areas between drill pads will be damaged by trampling and mobile equipment operation.

Utility corridor development will completely remove existing vegetation from portions of the corridor and much of the balance of the corridor areas will experience substantial trampling impact from mechanical activities.

Revegetation is called for on portions of these areas when backfilling and surface placement of overburden has progressed to a point where workable areas are available for rehabilitation and when construction is complete in utility corridors and operations have progressed through in situ areas that have been developed.

The existing vegetative complexes of these areas have evolved over long periods of time. The species and species groups are interdependent and in a reasonable degree of natural balance and stability. The natural balance between species and groups of species will be altered in some processing options (for example, in situ processing) or completely destroyed on others, such as mine development and processed shale disposal areas.

In general, revegetation can be initiated on such disturbed areas as soon as the activity is terminated. The nature of the resulting new plant communities and the pattern of the ensuing successional changes will also vary distinctly from site to site depending upon site characteristics, types of disturbance, species planted, revegetation methods, and subsequent management.

As described in Volume I, Chapter I, Section 2, a considerable body of information is available on revegetating native soils. Relatively successful cover establishment can be anticipated on disturbed native soils in areas such as utility corridors, roadside cuts, and similar circumstances. However, as explained in Section 3, Chapter II, Volume I, information on revegetation of processed shale and deeply disturbed parent soil materials is rather limited, research having emphasized grasses with only limited attention having been given to forbs and almost no long-term studies on shrubs. Thus, the optimum selection of species, germination and survival rate, and expected density of cover have not yet been fully established nor can the future pattern of succession be predicted with certainty.

If mixtures of native species, which include the major climax (or desired sub-climax) species, are used to revegetate disturbed native soils, natural progression may be relatively rapid. The planting of older age class shrub and tree seedlings could accelerate the establishment of more stable plant communities.

If exotic species are used, particularly as monocultures, successional changes will be much more extensive as the introduced species will eventually be replaced by natives beginning with aggressive invader species and ending with climax or "use sub-climax" species. Exotic plant monocultures can survive for extended periods with adequate management. However, they are susceptible to severe setback by adverse climatic conditions and insect or disease infections, destroying the cover and increasing erosion. Maintenance of non-native species would therefore require long-term management.

Establishment of initial cover and successional change on processed shale disposal sites will be constrained by the plant growth media, and the semi-arid climate, exposure, slope, and cultural practices, including temporary irrigation and fertilization. Revegetated processed shale areas will be fragile sites highly susceptible to damage from biotic influences such as improper grazing or fire.

For processed shale disposal and excavated areas, two broad options are available: (1) cover the site with native soils, and (2) use the processed shale or substrata as the plant growth media. If the former is used, and the processed shale is covered with native top soil to a sufficient depth, native plant species may become established and

succession toward a stable climax or sub-climax plant community should be similar to that on disturbed native soil sites. Conversely, the initial plant cover established directly on unleached processed shale would be limited to salt tolerant species. The new climax plant community would consist of plants adapted to the plant growth media and local climatic conditions. It would probably include species found in salt desert shrub types of the region.

Succession to climax or "use sub-climax" plant communities would be accelerated by planting mixtures of native species adapted to the new site conditions. The duration and amount of artificial fertilization and irrigation would also significantly affect succession. The reliability of establishing and maintaining an effective plant cover over the long-term is uncertain.

a. Tract C-a

(1) The approximate acreage of vegetation disturbed by underground mining of Tract C-a is shown in Table IV-6. This table also compares the acreage needed for total surface disposal with the acreages that will be needed if backfilling is used. Underground mine and surface retort development would result in elimination of existing vegetation or significant vegetation damage on the following acreages of the vegetation types on the tract and on associated off-site areas if all processed shale is disposed of on the surface:

TABLE IV-6.-Vegetation Impact Areas, Tract C-a, Underground Mine

Plant Communities	Vegetation Disturbed, Acres						
	Facilities	Mine and Overburden	Process Shale		Utility Corridors	Totals	
			Surface[1/]	Backfill[2/]		Surface[1/]	Backfill[2/]
Loamy slopes Big sage, serviceberry, wheatgrass	49	5	186	74	60	300	188
Pinyon-juniper Pinyon, juniper, serviceberry, stipa	42	2	558	222	30	632	296
Rolling loam Sagebrush, wheatgrass	21	3	56	20	30	110	74
Deep loam Sagebrush, stipa	7	0	40	16	20	67	43
Mountain swale Wheatgrass, wildrye	14	0	60	24	20	94	58
Loamy breaks Bitterbrush, serviceberry	7	0	30	14	10	47	31
Rough broken land Serviceberry, primrose Indian ricegrass	0	0	930	370	30	960	400
Totals	140	10	1,860	740	200	2,210	1,090

1/ Disposal totally on surface.

2/ Maximum backfilling of spent oil shale into mine workings.

Pinyon-juniper type	approximately	630	acres
Sagebrush types (loamy slopes, rolling loam, and deep loam sites)	"	480	"
Serviceberry, bitterbrush types (loamy breaks and rough broken and sites)	"	1,010	"
Wildrye, wheatgrass type	"	90	"
	approximately	2,210	acres

If processed shale is placed underground in mine voids to the maximum possible extent, the acreages of vegetation types affected will be as follows:

Pinyon-juniper	approximately	300	acres
Sagebrush types	"	300	"
Serviceberry, bitterbrush types	"	430	"
Wildrye, wheatgrass type	"	60	"
	approximately	1,090	acres

(2) Table IV-7 shows the approximate acreage of disturbance for specific plant communities if Tract C-a was developed as a surface mine. Surface mine development with surface disposal of processed shale and overburden would result in vegetation loss or damage to the following acreages of on-site and off-site vegetation types:

Pinyon-juniper	approximately	1,400	acres
Sagebrush types	"	2,260	"
Serviceberry, bitterbrush types	"	2,540	"
Wildrye, wheatgrass types	"	450	'
	approximately	6,650	acres

If overburden and processed shale is backfilled into the mine pit to the extent possible, the acreage of vegetation types affected will be as follows:

TABLE IV-7.-Vegetation Impact Areas, Tract C-a, Surface Mine

Plant Communities	Vegetation Disturbed, Acres							
	Facilities	Mine	Overburden	Process Shale		Utility Corridors	Totals	
				Surface1/	Backfill2/		Surface1/	Backfill2/
Loamy slopes Big sage, serviceberry, wheatgrass	75	360	300	380	182	120	1,235	1,037
Pinyon-juniper Serviceberry, stipa	40	180	100	1,000	456	80	1,400	856
Rolling loam Sagebrush, wheatgrass	35	180	150	120	54	60	545	479
Deep loam Sagebrush, stipa	20	120	120	180	91	40	480	391
Mountain swale Wheatgrasses, wildrye	20	120	100	170	91	40	450	371
Loamy breaks Bitterbrush, service-berry, Indian ricegrass	10	60	70	80	36	20	240	196
Rough broken land Serviceberry, primrose Indian ricegrass	0	180	140	1,940	910	40	2,300	1,270
Totals	200	1,200	980	3,870	1,820	400	6,650	4,600

1/ Disposal totally on surface.

2/ Maximum backfilling of spent oil shale into mine workings.

Pinyon-juniper type	approximately	860	acres
Sagebrush types	"	1,900	"
Serviceberry, bitterbrush types	"	1,470	"
Wildrye, wheatgrass	"	370	"
	approximately	4,600	acres

(3) The approximate acreages disturbed for particular plant communities by in situ processing is shown in Table IV-8. In situ shale oil extraction activities would eliminate existing vegetation from drill pad sites and result in considerable trampling and physical damage to vegetation on the areas between drill pads from mobile equipment operations. Thus, vegetation changes will take place on much of the surface area involved in in situ shale oil extraction activities. The acreages of the particular vegetation types involved are summarized as follows:

Pinyon-juniper types	approximately	310	acres
Sagebrush types	"	930	"
Serviceberry, bitterbrush types	"	130	"
Wildrye, wheatgrass types	"	160	"
	approximately	1,530	acres

b. Tract C-b

(1) Table IV-9 shows the approximate acreages disturbed for specific plant communities if Tract C-b were developed as an underground mine. It also shows the acreages needed if backfilling were employed. Underground mine and surface retort development would eliminate or significantly damage vegetation on the following acreages of the vegetation type on the tract and on associated off-site if all processed shale is disposed of on the surface:

TABLE IV-8 Vegetation Impact Areas, Tract C-a, In Situ Extraction

Plant Communities	Vegetation Disturbed, Acres					
	Facilities	Drilling	Overburden	Processed Shale	Utility Corridors	Total
Loamy slopes big sage, service-berry, stipa	18	300	0	0	200	518
Pinyon-juniper pinyon, juniper, serviceberry stipa	12	180	0	0	120	312
Rolling loam sagebrush, wheatgrass	9	150	0	0	90	249
Deep loam sagebrush, wheatgrass	4	100	0	0	60	164
Mountain swale wheatgrass, wildrye	5	100	0	0	50	155
Loamy breaks bitterbrush, service-berry, Indian ricegrass	2	50	0	0	30	82
Rough broken land serviceberry, primrose, Indian ricegrass	0	0	0	0	50	50
Totals	50	880	0	0	600	1,530

TABLE IV-9.-Vegetation Impact Areas, Tract C-b, Underground Mine

Plant Communities	Vegetation Disturbed, Acres						
	Facilities	Mine and Overburden	Process Shale		Utility Corridors	Totals	
			Surface 1/	Backfill 2/		Surface 1/	Backfill 2/
Pinyon-juniper Pinyon-juniper, service-berry, stipa	50	5	370	150	50	475	255
Loamy slopes Big sage, serviceberry wheatgrass	50	5	560	220	50	665	325
Rough broken land Serviceberry, primrose, Indian ricegrass	0	0	0	0	40	40	0
Rolling loam Sagebrush, wheatgrass	20	0	190	70	20	230	110
Deep loam Sagebrush, stipa	5	0	180	80	10	195	95
Mountain swale Wheatgrass, wildrye	5	0	180	70	10	195	85
Loamy breaks Bitterbrush, service-berry, Indian ricegrass	5	0	90	30	10	105	45
Brushy loam Serviceberry, wheatgrass	5	0	290	120	10	305	135
Totals	140	10	1,860	740	200	2,210	1,090

1/ Disposal totally on surface.
2/ Maximum backfilling of spent oil shale into mine workings.

Pinyon-juniper type	approximately	475	acres
Sagebrush types	"	1,090	"
Serviceberry, bitterbrush types	"	450	"
Wildrye, wheatgrass type	"	195	"
	approximately	2,210	acres

If processed shale is placed underground in mine voids to the maximum possible extent, the acreages of vegetation types affected will be:

Pinyon-juniper type	approximately	255	acres
Sagebrush types	"	530	"
Serviceberry, bitterbrush types	"	220	"
Wildrye, wheatgrass type	"	85	"
	approximately	1,090	acres

(2) In situ processing would disturb particular plant communities in the acreages shown in Table IV-10. The acreage of the particular vegetative types on which existing vegetation would be eliminated or seriously damaged by in situ shale oil extraction activities are:

Pinyon-juniper type	approximately	460	acres
Sagebrush types	"	810	"
Serviceberry, bitterbrush types	"	290	"
Wildrye, wheatgrass type	"	75	"
	approximately	1,635	acres

c. Tracts U-a and U-b

(1) The approximate acreage of vegetation disturbed by underground mining of Tracts U-a and U-b is shown in Table IV-11. This table also compares the acreage needed for total surface disposal with the acreages need if backfilling is used. Underground mine and surface retort development would eliminate or significantly damage vegetation on the following acreages of the vegetation type on the tracts and on associated off-site areas if all processed shale is disposed of on the surface:

TABLE IV-10 Vegetation Impact Areas, Tract C-b, in Situ Extraction

Plant Communities	Vegetation Disturbed, Acres					
	Facilities	Drilling	Overburden	Processed shale	Utility Corridors	Total
Pinyon-juniper, Pinyon-juniper, serviceberry, stipa	10	300	0	0	150	460
Loamy slopes Big sage, serviceberry, wheatgrass	20	290	0	0	150	460
Rough broken land Serviceberry, primrose, Indian ricegrass	0	0	0	0	120	120
Rolling loam Sagebrush, wheatgrass	10	150	0	0	60	220
Deep loam Sagebrush, stipa	0	100	0	0	30	130
Mountain swale Wheatgrass, wildrye	5	40	0	0	30	75
Loamy breaks Bitterbrush, serviceberry, Indian ricegrass	0	0	0	0	30	30
Brushy loam Serviceberry, wheatgrass	5	105	0	0	30	140
Totals	50	985	0	0	600	1,635

TABLE IV-11.-Vegetation Impact Areas, Tracts U-a and U-b, Underground Mine

Plant Communities	Vegetation Disturbed, Acres						
	Facilities	Mine and Overburden	Process Shale Surface1/	Process Shale Backfill2/	Utility Corridors	Totals Surface1/	Totals Backfill2/
Pinyon-juniper Juniper, service-berry, Indian ricegrass, stipas	90	5	1,120	440	110	1,325	645
Salt desert breaks Four-wing saltbush, greasewood, Indian ricegrass	50	5	560	230	50	665	335
Loamy salt desert Shadscale, winterfat, wildrye, stipas	0	0	180	70	10	190	80
Rough broken land Big sage, black sage, bluegrasses	0	0	0	0	30	30	0
Totals	140	10	1,860	740	200	2,210	1,090

1/ Disposal totally on surface.

2/ Maximum backfilling of spent oil shale into mine workings.

Pinyon-juniper type	approximately	1,325	acres
Saltbush-greasewood type	"	665	"
Shadscale-winterfat type	"	190	"
Sagebrush types	"	30	"
	approximately	2,210	acres

If processed shale is placed underground in mine voids to the maximum possible extent, the acreages of vegetation types affected will be:

Pinyon-juniper type	approximately	645	acres
Saltbush-greasewood type	"	335	"
Shadscale-winterfat type	"	80	"
Sagebrush types	"	30	"
	approximately	1,090	acres

(2) Table IV-12 shows the acreages of specific plant communities disturbed if Tracts U-a and U-b used in in situ processing. The acreages of the particular vegetative types on which existing vegetation would be eliminated or seriously damaged by in situ development, primarily trampling by mobile equipment, are:

Pinyon-juniper type	approximately	5,590	acres
Saltbush-greasewood type	"	2,190	"
Shadscale-winterfat type	"	430	"
Sagebrush types	"	490	"
	approximately	8,700	acres

d. Tracts W-a and W-b

The approximate acreages of vegetation disturbed by in situ processing with Tracts W-a and W-b is shown in Table IV-13. The acreages of the particular vegetative types on which existing vegetation would be eliminated or seriously damaged by in situ shale oil extraction activities are:

TABLE IV-12 Vegetation Impact Areas, Tracts U-a and U-b, In Situ Extraction

Plant Communities	Vegetation Disturbed, Acres					
	Facilities	Drilling	Overburden	Processed shale	Utility Corridors	Total
Pinyon-juniper juniper, serviceberry, Indian ricegrass stipas	30	5,230	0	0	330	5,590
Salt desert breaks Four-wing saltbush, greasewood, Indian ricegrass	20	2,020	0	0	150	2,190
Loamy salt breaks Shadscale, winterfat, wildrye, stipas	0	400	0	0	30	430
Rough broken land Big sage, black sage, bluegrasses	0	400	0	0	90	490
Totals	50	8,050	0	0	600	8,700

TABLE IV-13 Vegetation Impact Areas, Tracts W-a and W-b, In Situ Extraction

Plant Communities	Vegetation Disturbed, Acres					
	Facilities	Drilling	Overburden	Processed Shale	Utility Corridors	Total
Very shallow soil black sage, bluebunch wheatgrass	35	4,119	0	0	323	4,477
Saline upland big sage, western wheatgrass	10	1,524	0	0	150	1,684
Shallow sandy shadscale, sage-brush, bluegrass	5	927	0	0	120	1,052
Saline lowland saltgrass, seages, greasewood	0	50	0	0	7	57
Totals	50	6,620	0	0	600	7,270

Black sage type	approximately	4,477	acres
Big sage type	"	1,684	"
Shadscale type	"	1,052	"
Saltgrass type	"	57	"
	approximately	7,270	acres

The major consequences of removal or reduction of vegetation will be losses in soil stability, wildlife habitat, and livestock forage. The effect of vegetation changes on wildlife populations and on livestock grazing are explained in Sections D and E. Revegetation measures will be carried out in accordance with the lease stipulations described in Chapter V. The expected pattern of successional changes and the nature of the resulting plant communities is described in Volume I, Chapter I, Section D.

6. Impact on Specific Land and Cultural Features

a. General

Impacts on water, air quality, fauna, grazing, recreation, and the socio-economic environment are covered in Sections B through G of this chapter. This section discusses the effects on specific physical and cultural features not elsewhere considered (See Figures II-3, II-5, II-9, II-11, II-15, II-17, Chapter II, Volume II).

As with other impacts, the nature and severity of these effects will depend upon the type, size, and design of each specific oil shale operation. As an example, simply choosing a different access route to a tract might change the impact on a particular feature from severe to virtually zero.

b. Colorado Tracts

(1) Tract C-a.- If this tract is mined by surface mining methods, it is expected that the entire surface would be excavated leaving a different physical configuration than presently exists. At this time, the ultimate land form cannot be determined since it will depend upon the particular mine and waste disposal system design, as well as the type of restoration adopted. If backfilling of the pit is employed, approximately the same elevation as the original surface may be expected after the operation is completed. However, variations in backfilling could make the elevation higher or lower. The canyons of Dry Fork, Corral Gulch, and Box Elder Gulch in this roughly 3-mile area will cease to exist. In addition, Water Gulch,

a tributary to Corral Gulch which is west of the tract, or some other nearby area, may be used for disposal of overburden as illustrated in Figure IV-4. In this case, it would also have a new physical configuration upon completion of mining operations (See Figure IV-5).

Underground mining would have much less effect upon the land surface unless subsidence were to occur at some future date. With an underground mine, it is probable that the drainage pattern over most of the area of the tract would be unaltered except to divert runoff around mine and plant facilities.

A private hunting camp, consisting of several structures, is located in the southern half of Sec. 33, T. 1 S., R. 99 W. It is used during the fall for a few weeks each year. The owners of the camp have title to 160 acres of the surface. Oil, gas, oil shale, and other rock valuable as a source of petroleum and nitrogen are reserved to the United States. In many instances, industrial operators will purchase the surface rights from present owners.

Surface mining of the tract would eventually necessitate removal of the buildings and preclude any other surface use of the area until mining was completed and restoration begun. Underground mining would not preclude use of existing improvements unless subsidence of the surface took place. The cumulative effect of any subsidence would not take place for many years and it is unlikely the buildings would remain in serviceable condition that long. In any event, the owners could retain use of the surface until mining operations directly interfered. Thus, the impact on the hunting

camp would depend largely on the mining method used and how rapidly the tract is developed.

Present access to Tract C-a is via an unimproved road up Corral Gulch and Box Elder Gulch. This road would probably be improved and continue to provide public access through the area. Its improvement would not affect any residential or other structures. Alternative access could be developed from Douglas Creek Valley about 10 miles to the west. This would require extensive road building through Cathedral Bluffs, resulting in a greater amount of traffic through more remote lands and greater impacts on aesthetics than the Corral Gulch road improvement. Some of the existing primitive roads across the tract are now used primarily by ranchers and hunters. These might be blocked by development forcing use of alternate routes around the tract.

The Reigle Ranch, located about 3 miles southeast of Tract C-a in Sec. 19, T. 2 S., R. 98 W., has been sold to an oil company with the exception of the lands immediately around the ranch headquarters buildings which would probably continue to be occupied year round. The ranch lands have been leased for ranching purposes. A ditch along Ryan Gulch in this area is used to irrigate hay and pasture lands. It is closest to the lease tract in Sec. 24, T. 2 S., R. 99 W., but should not be affected by operations on the tract unless its water source is affected or the water right converted to other use.

Development of Tract C-a should not directly affect residents or current operations of the Reigle Ranch. The sales terms,

lease-back arrangements, and the plans of the majority titleholder are not known. Such factors would determine whether the operation continues as at present.

(2) Tract C-b.- Development of this tract would probably be by either a conventional underground mine or some in situ process. Thus, radical changes in the tract surface from mining are unlikely unless subsidence occurs. Future subsidence effects could significantly modify stream courses. In this case, surface displacement of tens of feet may occur if backfilling is not used, and of less than ten feet if backfilling is used. However, it is not possible to precisely predict the location or degree of this impact. Considering the state of technology, in situ mining seems less likely than underground mining. The surface disposal plan and the resulting surface area requirement will affect the land impact expected from waste disposal. Three areas which may be used for disposal are the West, Middle, and East Forks of Stewart Gulch. Several miles of these would be filled with compacted spent shale to a maximum depth of 250 feet if all material were disposed of on the surface. If 60 percent of the spent shale is placed in mined out areas underground, as is theoretically possible, the requirement would be reduced to only the West Fork of Stewart Gulch. The portions of these gulches used for surface disposal would be radically changed. Streamflow or runoff would be diverted from the spent shale piles, thus changing the drainage pattern.

The following ranches are in the vicinity of Tract C-b: the Gerald Oldland Ranch in Sec. 3, T. 3 S., R. 96 W.; the Walter Oldland

Ranch in Sec. 32, T. 2 S., R. 96 W.; the Redd Ranch in Sec. 36, T. 2 S., R. 97 W.; the P. L. Ranch in Sec. 35, T. 2 S., R. 96 W.; and the Redd Cow Camp in Sec. 30, T. 3 S., R. 96 W. These ranches have been sold to oil or oil shale companies with the exception of small acreages retained at ranch headquarters by the former owners who still occupy them. The balance of the private ranch lands has been leased back and ranching activities continue, including grazing on the Federal lands. The two Oldland ranches and the P. L. Ranch headquarters are occupied year round. The Redd Cow Camp and the Savage Cabin at the mouth of the middle Stewart Gulch are occupied in the summer. The Redd Ranch house burned years ago and there has been no site occupancy since that time.

Increased traffic and associated noise would have the greatest impact on year-round residents of these ranches. However, development of Tract C-b would not involve relocation of any residents even if ranching operations continue. The ranch sales terms, lease-back arrangements, and the plans of the present titleholders are not known. Such factors would determine whether these ranch operations continue. Oil shale development on Tract C-b is not expected to interfere with ranching operations.

Since the Stewart School (See Figure II- 5, Chapter II) was moved over 10 years ago to the Rock School site to provide housing for teachers, it would not be affected.

The irrigation ditch which runs along Piceance Creek in this area is used by all ranchers along the creek to irrigate meadow lands for pasture and hay. The use of the ditch should not be

affected by oil shale development on Tract C-b unless the ranch operations are terminated or existing water rights are converted to other uses. The likelihood of either possibility is unknown.

Access to this tract could be a problem. Present access from the vicinities of the Walter Oldland and P. L. Ranches requires crossing private lands and does not constitute legal public access. Alternative access could be gained with a new road across Piceance Creek from the present paved road in Sec. 25, T. 2 S., R 97 W. to connect with the existing Bureau of Land Management road which runs along the ridge on the east side of Scandard Gulch. This route would require crossing private land in the Piceance Creek Valley but would avoid ranch headquarters areas and should not significantly affect the residents. Access from any other direction would be much longer and require extensive road building resulting in greater land requirements and "access" impacts for local residents.

c. Utah Tracts, U-a and U-b

These tracts are believed suitable for development by underground mining or by an in situ process. Thus, the surface would not be radically modified by the mining operation. Surface disposal of spent shale would create the greatest physical change. If Evacuation Creek Valley is used as a disposal site (See Figure IV-8) spent shale would fill it to a maximum depth of 250 feet (See Figure IV-9). If all such waste from both tracts were disposed of on the surface, some 5 miles of the creek would be required. If 60 percent of the waste is placed back in the mines,

about 2 1/2 miles would be required. The topography of these stream portions would be radically changed as discussed earlier for Tract C-a. Streamflow and runoff would be routed over, under, or around the spent shale pile, changing the present drainage pattern.

The physical and cultural features in the area of the tracts are the White River, which runs generally from north northeast to west southwest within a quarter mile of the north central boundary of U-b, crossing the extreme northwest corner of U-b and dipping into the extreme north central portion of U-a; the Ignatio Stage Station; 2 pipelines; a number of abandoned gilsonite mines; a few gas wells of the Southern Canyon Gas Field; scattered drill holes; the site of Watson, an abandoned gilsonite mining town; and a gaging station on the White River. Except for the White River itself, short stretches of one of the pipelines, and a few drill holes, these features are entirely off the tracts. The Ignatio Stage Stop, which is about two miles north of Tract U-b, is on private land in Sec. 2, T. 10 S., R. 24 E. and has been suggested for designation as an historic site. It could suffer from vandalism with the influx of workers to the area. The site is unoccupied at present and, if designated as an historical site, might need some form of protection. The Watson site is on private land in Sec. 7, T. 11 S., R. 25 E., two to three miles south of Tract U-b and two to three miles southeast of Tract U-a. It was on a rail line which was taken out in 1937 and all structures have since been removed.

One of the two pipelines is a major transcontinental line between Texas and Seattle belonging to El Paso Natural Gas Company.

The other is an old gilsonite slurry line going to Fruita, Colorado, which is no longer used. It is not considered likely that serious effects on these lines would occur.

The gas wells of the Southern Canyon Gas Field are all believed to be shut in with no current production.

There are no residents who would be affected by development in the general area of the tracts. The nearest town, Bonanza, Utah, is located 25 to 30 miles from the tracts.

d. Wyoming Tracts, W-a and W-b

Development by in situ methods has been assumed for both of these tracts. Thus, the surface lands would not undergo extreme change over large areas unless the in situ process resulted in surface subsidence. The probability of this is slight, but may cause elevation changes of inches.

The most notable physical feature in this area is Kinney Rim which runs in a north northwest-south southeast direction along the southwest boundary of both tracts. A bladed unsurfaced road comes across the Rim in Secs. 18 and 19, T. 14 N., R. 99 W., from State Highway 430 which is about 14 miles west of the tracts. If this route were to be used as access to the tracts, it would need to be improved. Alternate access to both tracts might be obtained from an unsurfaced county road extending south for approximately 36 miles through Bitter Creek to the Eversole Ranch which is about 8 miles northeast of the tracts. The physical impacts on the area from widening and surfacing a presently little improved seasonal road

would be no more than those from a routine county road operation (enlarging cuts and fills, widening, improving drainage).

Other physical features include approximately 11 scattered stock reservoirs and ponds, one corral, several springs, 7 gas wells, and a few drill holes. With the exception of 2 drill holes on Tract W-a and one ephemeral pond near it, none of these features are close to the tracts. All of the gas wells are farther than 2 miles from either tract. No significant impacts are anticipated on these features.

B. Impact on Water Resources

1. General

Water use and the impact on the water resources of the prototype lease tracts depend upon the types of mining, processing procedure, and spent shale disposal options employed on each tract. The probable means of development have been detailed in Chapter III. It should be noted that a significant amount of hydrologic data were obtained by private interests during the fall of 1971 and during 1972. At this printing, these data are unpublished, but were considered and used in preparation of the composite information presented in this section.

2. Colorado Tracts

a. Tract C-a

(1) Demand - Assuming surface mine development with an output of 100,000 barrels of oil per day, the total operation (including spent shale disposal and shale oil upgrading) would consumptively use about 16.5 to 22.5 cubic feet per second, or 12 to 18 thousand acre-feet per year. Associated urban development could increase this to 13 to 20 thousand acre-feet per year.

Water consumption estimates for a "unit" 100,000 barrel per day plant are given in Table IV-14. About one-half of the total is used in the disposal operation to give mechanical stability to the

Table IV-14.- Typical Water Consumed for a 100,000 Bbl/Day Oil Shale Plant

	Acre-feet/year
PROCESS REQUIREMENTS	
Mining and Crushing	730-1,020
Retorting	1,170-1,460
Shale Oil Upgrading	2,920-4,380
Processed Shale Disposal	5,840-8,750 1/
Power Requirements	1,460-2,040
Revegetation	0- 700
Sanitary Use	30- 70
Subtotal	12,150-18,420
ASSOCIATED URBAN	
Domestic Use	1,140-1,530
Domestic Power	110- 150
Subtotal	1,250-1,680
GRAND TOTAL	13,400-20,100
AVERAGE VALUE	16,800

1/ Water used is 20 percent by weight of the disposed spent shale.

Sources: Same as those used in Volume I, Chapter III, Table III-5.

spent shale pile (see Chapter I, Volume I). Since leaching from this pile is expected to be minimal (Chapter I, Volume I), the water that would be required in disposal operations does not need to be of high quality. Similarly, high quality water is not required for local dust control in the plant area. This suggests that water other than that obtained directly from the Colorado River system can be used for these operations.

(2) Supply - As explained in Chapter II, B.1.d, surface water resources are available in Colorado; however in the early development phase, surface water may not be needed to support development on Tract C-a since adequate quantities of ground water may be available (see Volume I, Chapter III, Section C.2). Core holes drilled on or near Tract C-a suggest that the transmissivity of the water bearing zones ranges from 3,100 to 21,000 gallons per day per foot.

A surface mine may need to pump only minimal amounts of ground water until the water table is reached. After the water table is reached, which may be 200 - 300 feet below the surface of the ground, the minimum pumping rate would be that required to keep the pit floor dry. This rate may at the same time be adequate to satisfy processing needs (between 18 - 27 cfs) as discussed in the subsection (3) below. Depending on the thickness of the formation to be dewatered, the actual location of the wells, and the mine development plan, the maximum amount of water that may be pumped from Tract C-a is estimated to be 30 cfs, which would be expected to decrease over a 30-year interval to a level of about 18 cfs.

As previously stated, to keep the floor of the pit dry, the water table in the vicinity of the mine must be lowered at least as fast as the pit floor. After excavation has proceeded to the water table, a series of wells could be used to lower the water table and in so doing, a ground-water supply having relatively low salinity could be developed. Initially the water would be of good quality above and possibly below the Mahogany Zone. Eventually, the water from the lower zone would become more saline as water moved toward the cone of depression from downdip. Thus, once mining commenced below the Mahogany Zone, water more saline in character would have to be pumped to lower the pressure in order to reduce inflow and to prevent blowouts.

This pumped water could be used to meet the water requirements of crushing, mining, and processed shale disposal. Depending on the salinity, the produced water may also be suitable for retorting, refining, and possibly for supplying the drinking water and sanitation needs of the plant. During later stages of development surface water may have to be brought to the site. Although direct flow-water is available from both the Colorado and White Rivers part of the time, it would have to be augmented with storage water from the Green Mountain and Ruedi Reservoirs (or other reservoirs that have been authorized but not yet built) to obtain a firm water supply.1/ Water from either the Colorado or White River Basin would

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1/ Colorado has 167,000 acre-feet of water potentially available to support oil shale development; currently, Green Mountain and Reudi Reservoirs have 78,000 acre-feet available (See Volume I, Chapter III, Section B). The total water required for a 100,000 barrel per day plant is 16,800 acre-feet per year (Table III-5, Chapter III, Volume I). Thus, sufficient water is potentially available from surface sources to fully support development on Tract C-a.

have to be conveyed to the tract through facilities constructed by the operator. Ice formation undoubtedly would hinder transport of water via canals; therefore, terminal storage or buried pipelines would be necessary.

(3) Supply-Demand Relationship - A diagram showing water supply and demand for this type and size of operation is shown in Figure IV-10. While it is difficult to state specifically the amount of ground water that will be pumped from Tract C-a, a maximum expected upper limit is 30 cubic feet/second, which could be produced from a series of wells spaced throughout Tract C-a. Uncertainties remain concerning the actual supply-demand relationship and these are reflected by the range of estimates shown in Figure IV-10. The demand is shown as the minimum and maximum demand for both low and high quality water. For Tract C-a, the demand for low quality water may be met by the supply of such water that is pumped to keep the surface mine dewatered. However, the demand for high quality water may require water from the surface sources considered in part 2 above, particularly in the later stages of development. If the initial water pumped from wells is less than 30 cubic feet/second, the supply-demand relationships will change to reflect less excess water and a greater amount of surface water will be required to supply the demand needs.

As the illustration indicates, different quantities of water and different qualities of water will be produced at different stages of mining. It should once again be noted that Figure IV-10 illustrates the maximum expected supply condition; that is, that relatively large amounts of water will be produced from the mine and that a large part will be poor in quality.

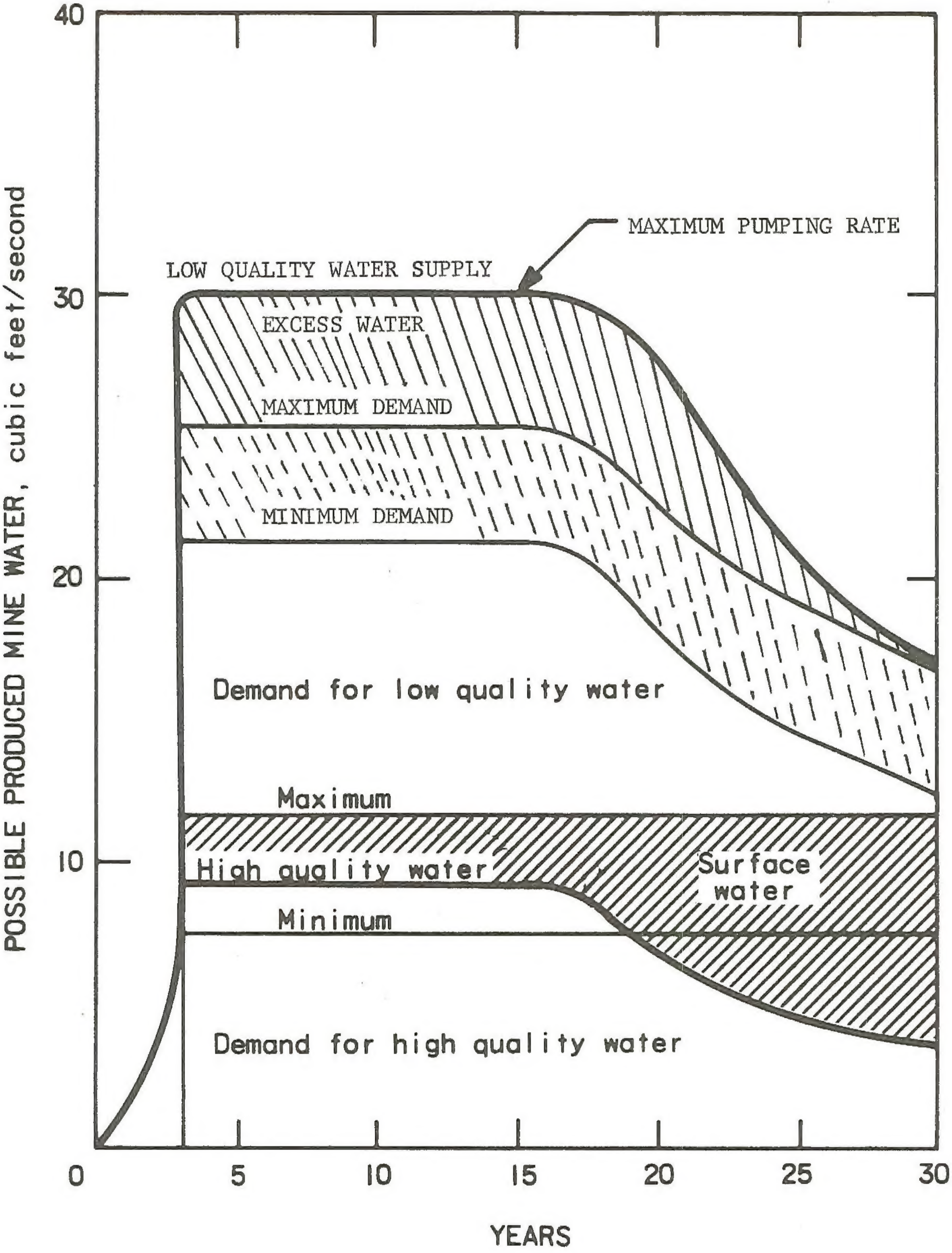

FIGURE IV-10.-Water Demand-Supply Relationship for a Hypothetical Surface Mine Operation, Tract C-a.

Demand for water for a 100,000 barrel per day surface mine was detailed in Volume I, Chapter III, Section C.1. Accordingly, the relationship between demand and supply for water for such a complex on Tract C-a is shown in Figure IV-11. As this diagram shows, water is available from the mine through dewatering, from surface sources, and from the retorts and shale oil upgrading. Using the maximum expected rate of withdrawal of 30 cubic feet/second, it is assumed that the rate of the low quality water produced from the mine would be 21 cubic feet/second (15,300 acre-feet/year) and that high quality water produced from the mine would be 9 cubic feet/second (6,600 acre-feet/year).[1/]

Should lower volumes of mine water be pumped, the impacts associated with excess water could be reduced. The optimum situation would be a ground water supply equal to the demand for the plant. If the ground water supply is less than demand, diversion of water from surface sources would be necessary, which is most likely to occur during the later stages of mine development. If all the water pumped is of low quality, then excess water would require disposal and surface water would need to be diverted for high quality water uses.

Produced mine water of low quality would be suitable for dust control during mining and crushing operations and for processed shale disposal. The total water needs for these processes could

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1/ Assumptions based upon: (1) hydrologic data given in Volume I, Chapter II, Section B.5.b, and in Chapter II, Section B.1.d of this volume, and (2) the hypothetical mine development plan, Chapter III, Section A.2 of this volume.

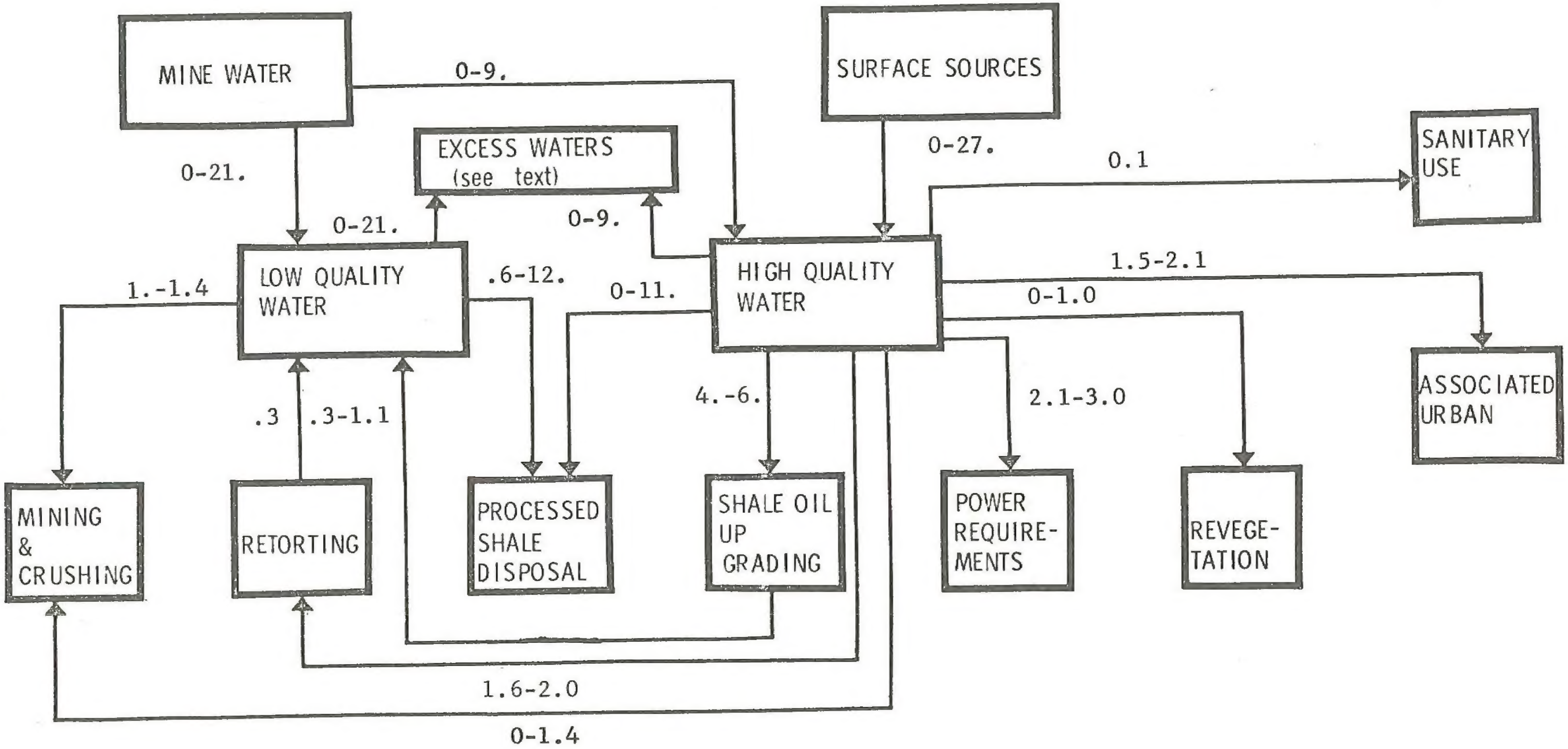

Figure IV-11. Demand and Supply for Water for a 100,000 Barrel per Day Surface Mine, Tract C-a, cubic feet/second (assuming 30 cfs pumped and that 9 cfs will be of high quality and 21 cfs will be of low quality water)

amount to between 9 and 13.4 cubic feet/second (6,600 to 9,800 acre-feet/year). Under these assumptions, large amounts of low quality mine water would be available for the processing needs over the 30-year development schedule. Conversely, if less mine water is produced, it may necessitate use of high quality water from surface sources for processed shale disposal and/or mining and crushing.

Water processing needs, which require a higher quality (less than 2,000 mg/1 dissolved solids), include retorting, shale oil upgrading, power requirements, revegetation, and sanitary use. Associated urban development will require water containing less than 1,000 mg/1 dissolved solids. For a 100,000 bbl per day shale oil complex, these high quality water requirements total 9.3 to 14.1 cubic feet/second, or 6,800 to 10,300 acre-feet/year (See Table IV-6). If large amounts of mine water of high quality are produced, this water could be used to augment surface sources.

In summary, on Tract C-a, it is likely that ground water in sufficient quantities and qualities will initially be available from mine dewatering. This water will be of different quality at different times as the dissolved solids content changes with depth. Its use to meet various processing needs will change over time. Even if large quantities of high quality ground water are available initially, later in the developmental stage greater

amounts of water might have to be diverted from surface sources. Precise quantification of the actual relationship between demand for and supply of water will be possible only from actual operations.

(4) Impacts - As water is produced from the mine, the lowering of the water level in the nearby area could cause low quality water to migrate toward the mine and eventually be withdrawn. Thus, by the time a mine was dewatered to the bottom of the oil shale strata, the quality of the mine water would probably deteriorate, ruling out use for retorting, refining, or other operations requiring high quality water.

Calculations were made to determine the distance to which the ground water pumping might affect wells and springs and the magnitude of water level decline for different distances and times. These calculations were made using the Theis non-equilibrium equation (1). To simplify the calculation procedure, pumping was assumed to be from a single source located at the center of the tract rather than from a dispersed well field. In actual operations, a well field would be necessary to dewater the mine. Assuming each well could be pumped at an initial rate of 1 cfs (about 650,000 gpd), 30 wells would be required if it is necessary to withdraw 30 cfs to dewater the mine. A transmissivity of 10,000 gpd/ft and a storage

coefficient of 10^{-1} were used in accordance with the values described in Chapter II, Section B.1.d of this volume. The maximum predicted yield of 30 cubic feet/second was used as the pumping rate. The calculations for each time-frame were carried to the distance at which draw-down approaches zero feet. The results of these calculations are presented in Figure IV-12.

The calculations are based on a simplified assumption that pumping would continue at a rate of 30 cubic feet per second throughout the 30-year life of the mine. In actual operations, this maximum rate of withdrawal would be expected to decline steadily after the maximum pit floor depth had been reached. However, a 30 cubic feet/second rate does indicate the maximum expected impact. As shown in Figure IV-12, the effects of pumping are negligible beyond a radius of 40,000 feet (about 8 miles).

Those wells and springs within a radius of about 10,000 feet would completely dry up; 3 wells and 9 springs fall in this classification for Tract C-a as shown in Figure II-24. The wells and springs beyond a distance of 10,000 feet would experience lowered water tables, the impact becoming less severe with distance. For example, 2 water wells are located from 10,000 to 20,000 feet from the assumed pumping center; these locations would experience a lowered water table of from 320 to 180 feet at the end of the

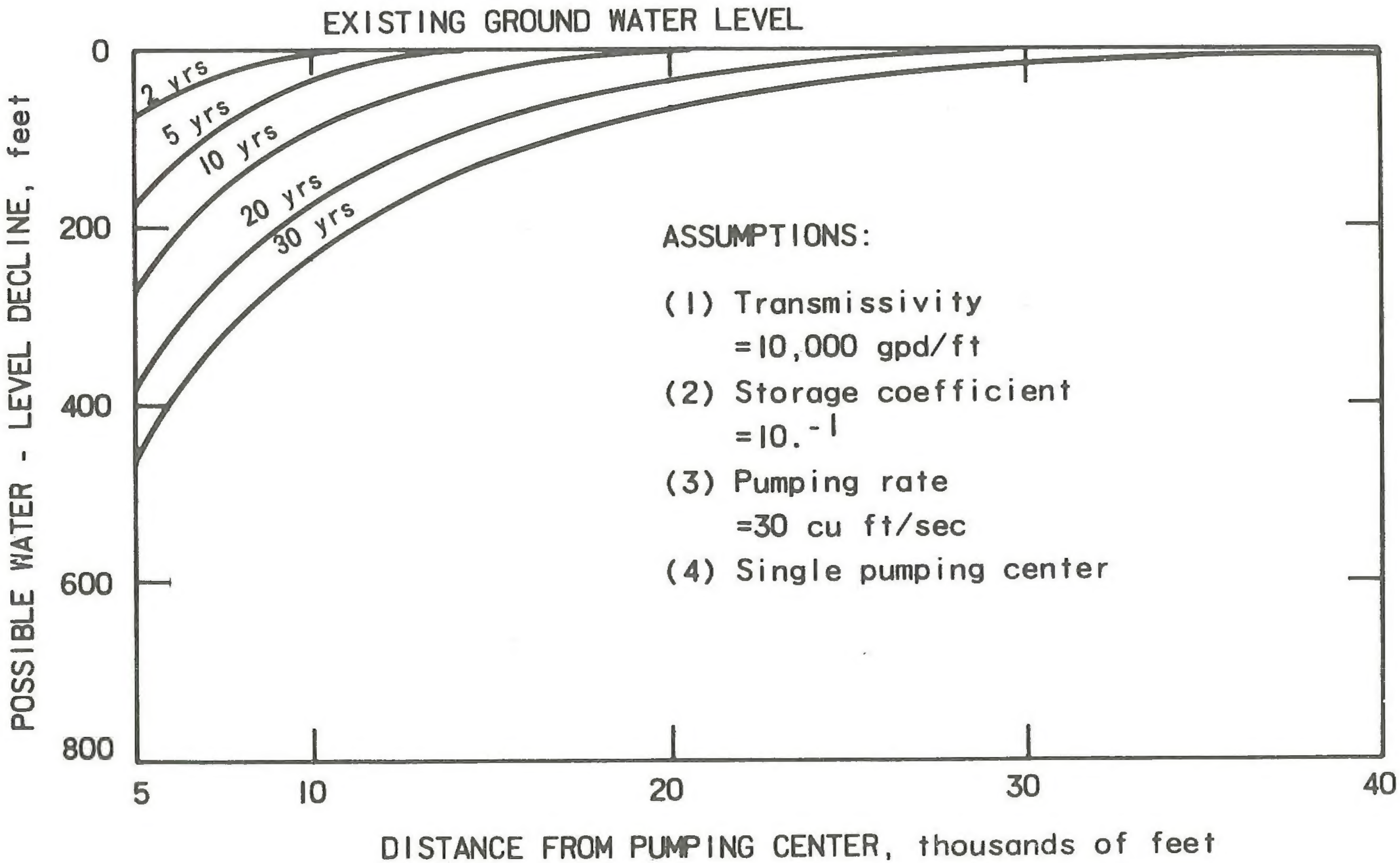

FIGURE IV-12.-Estimated Decline of Ground-Water Levels at Different Times and Distance from a Mine in Tract C-a located in the Center of the Tract.

30-year period. Five water wells located from 20,000 to 30,000 feet away would experience a 40 to 90 foot lowering of the water table; 3 wells from 30,000 to 40,000 feet away would experience a zero to 20-foot lowering of the water table by the end of the 30-year period. In addition, 37 springs within the 40,000 foot radius could experience impacts ranging from reduced flow to cessation of flow. Some of the springs are fed by perched water and would not be affected. However, any reduced flow would ultimately reduce the amount of water reaching Yellow Creek. These calculations assume the maximum impact. In all probability the impact will be less during actual mine development.

Saline water in excess of the amount needed for dust control, crushing, mining, and processed shale disposal could be desalted and used to supplement fresh water supply, be released to Yellow Creek or its tributaries, or the untreated water might be injected into the central part of the leached zone aquifer which is located east of Tract C-a. Ground water in the leached zone in the central part of Piceance Creek Basin has a dissolved solids content of 20,000 mg/1 or more.

The injection of saline water into the leached zone would cause a pressure build-up in the zone, the nature of which depends upon:

(1) the injection rate, (2) the transmissivity and storage coefficient of the receiving zone, (3) the length of time after injection begins, and (4) the distance from the injection well. The injection rate and pattern of dispersal can be controlled by the number and location of the injection wells. To demonstrate possible mine water problems, Coffin and Bredehoeft (2) used an estimated transmissivity for the leached zone in the central part of the basin of 20,000 gallons per day per foot and a storage coefficient of 10^{-4}. They used the coefficients to compute the change in hydraulic pressure with time and distance. The same coefficients are used to estimate pressure build-up from injection, as shown in Figure IV-13. Interference between wells can be controlled by appropriate spacing, pumping rates, and the number of injection wells. If injection were into the leached zone where it had been dewatered then a much larger storage coefficient might be present (10^{-1}) and pressure buildup would be less rapid until the dewatered zone were filled. If it were necessary to keep the leached zone dewatered, then either injection wells would need to be farther from the area or larger quantities of water would need to be pumped.

To evaluate the potential pressure increases that might be caused by injection of excess water in the leached zone, calculations were made assuming an average injection rate of 450 gpm per well during the first 10 years, 225 gpm during the second 10 years, and 158 gpm during the third 10 years based on a declining quantity of excess water; a transmissivity of 20,000 gallons per day per foot;

and a storage coefficient of 10^{-4}. The calculations show (Figure IV-13) that at a distance of 10 feet from the injection well, the pressure increase will be equivalent to 58 feet of water at the end of the first 10 years (it would be more in the wellbore due to boundary conditions at the interface between the wellbore and the aquifer); an additional increase of 24 feet during the second 10 years; and another 19 feet during the third 10 years, making a total of about 100 feet for the 30-year period. At a distance of 5,000 feet, the pressure increase caused by one injection well could be a hydrostatic head change of 42 feet at the end of 30 years. The pressure increase or water level increase at a point midway between two wells spaced two miles apart would therefore be about 84 feet. The effect due to the pressure interference of the two wells on each other would be an additional 38 feet of water head added to the increase in each well after 30 years. If large numbers of wells were required to inject the excess saline water, the mutual interference among wells would add up to hundreds of feet of water head change over a large area. If the injection wells were drilled on the tops of ridges, the initial depth to water below land surface would permit gravity injection at the well head but pressure increases would make injection pumps necessary if large quantities were injected.

Injection and storage of the excess saline water from Tract C-a would permit its later use for spent shale disposal. The amount of excess water from each succeeding mine should decrease, as the dewatered areas expand outward from the earlier mines,

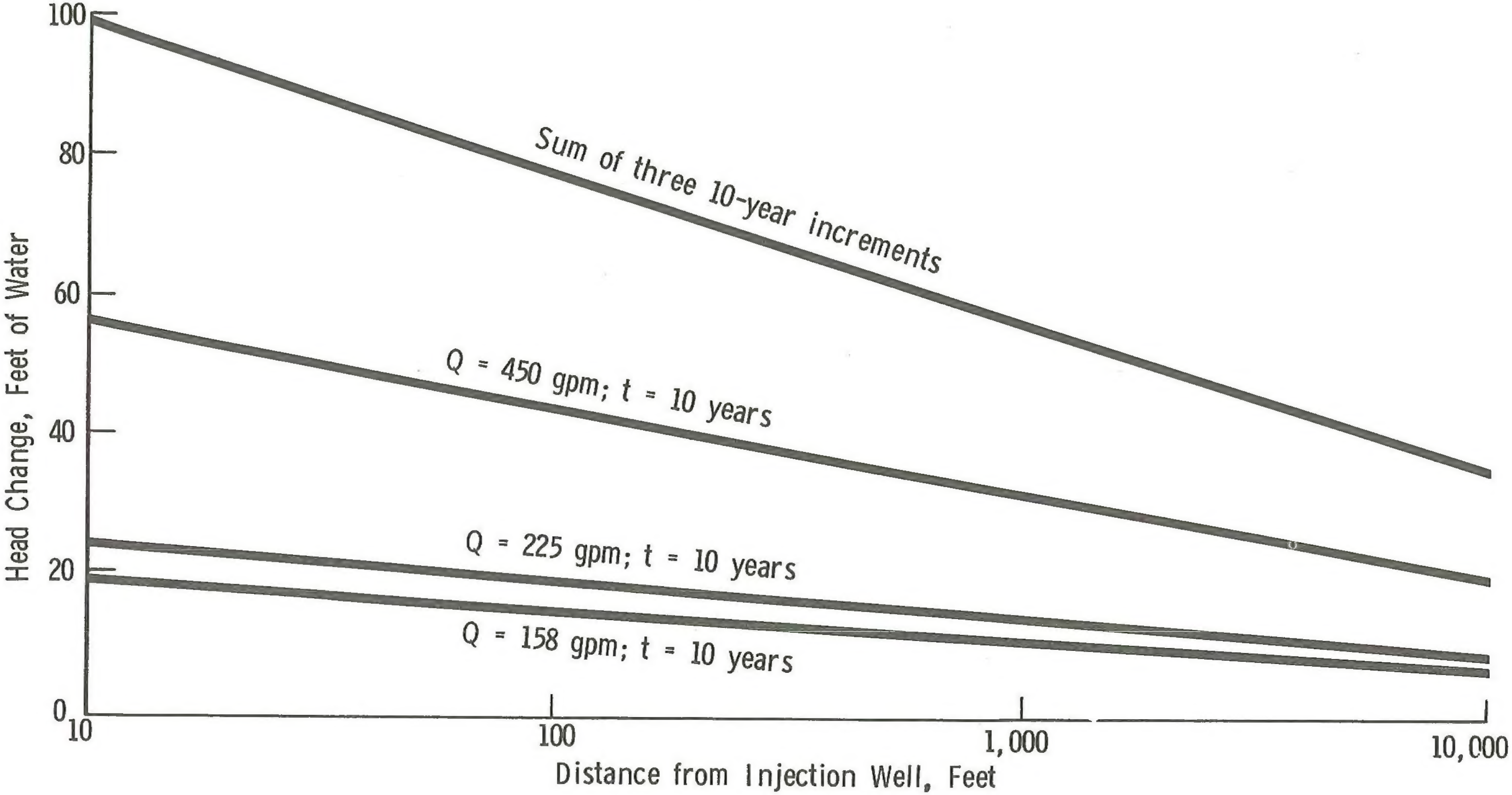

Figure IV-13. Change in Head Caused by Injection at the Rate Shown into One Well.

unless the new mines are completely outside the earlier cones of depression, or are within the cone of impression caused by injection of saline water from other mines.

An increase in the hydraulic pressure in the leached zone in the central part of the basin will increase the rate of flow upward locally through the overlying Mahogany Bed into the upper water-bearing zone and eventually into the lower reaches of Piceance and Yellow Creeks. Again, this effect of injection can be minimized by proper well spacing and injection rates, but the wells would have to be dispersed over a large area and miles (probably less than 100) of pipeline would be required to inject the possible excess. In the central Piceance Creek Basin, the quality of water in the upper zone is naturally degraded by upward leakage from the leached zone to the upper zone. The quality of water in Piceance and Yellow Creeks would probably not be degraded initially. However, with time, the volume and/or the salinity of the water reaching surface streams may increase or decrease. Thus, depending on combined pumping and injection, the total salt load (includes fluoride, sodium, bicarbonate, chloride and other ions) contained in the leached zone water would degrade the White River should injection cause an upward movement and increase the surface discharge of such water.

Channel erosion and sedimentation would be increased over current levels by increased discharge. If the discharge were increased by 5 to 30 cfs and dissolved solids content ranged from 1,000 to 2,000 mg/l, from 13 to 161 tons per day of salt would be added to the Colorado River system--approximately the same amount that is already added by the Piceance Creek in Colorado.[1/]

1/ Salt yield data for Yellow Creek, which would be affected, are not available, but the impact would be similar, but of less magnitude, to that on Piceance Creek.

Minor amounts of sediment originating from plant, road, and pipeline construction would be released to Corral Gulch and Stake Springs near the site and hence to Yellow Creek and the White River. This sedimentation would be of short duration. Heavy rains may also wash sediment and mineral matter into local streams.

In some instances, processed shale may be transported from the tract to the disposal site as a 50 percent water slurry. In order to prevent significant seepage of contaminated water into streams or into aquifers, water draining from the slurry (which ultimately would dewater to about 20 percent moisture) would be caught in a holding basin, or behind a downstream dam that would also catch runoff and underflow. The resulting water, after settling, would be high in dissolved solids but would be suitable for recycling as slurry makeup water. Accidental flood destruction of holding ponds would constitute a potential source of sediment and excess salt released to Yellow Creek (for a hypothetical analysis, see Volume I, Chapter III, Section C.5.b).

Storage tanks and pipelines at the retorting facility are recognized as potentials for stream pollution. Rupture of one of the pipelines could release from 700 to 1,400 barrels of oil, degrading nearby Yellow Creek. However, the frequency of this and similar accidents occurring is not quantifiable at the present time.

The above predictions of environmental impact have assumed that the oil shale at Tract C-a would be developed by surface mining, as proposed in the site nomination documents. It is possible that this site may be developed using underground mining or in situ processing. In the event one of these other processes is used, oil production is

estimated to be 50,000 barrels per day and water requirements will correspondingly be about one-half and one-quarter, respectively, of the amounts estimated for surface mining. In general, dewatering an underground mine will lead to the same impacts considered above, but the water needs and expected inflow of water to the mine will be similar to that detailed for Tract C-b, below.

The probability of in situ retorting on this tract is low, but is possible. If employed, the positive pressures used in this approach could force organic materials formed in the retorting process into the aquifers underlying Tract C-a, thus degrading these waters. Definition and solution of this potential hazard will require drilling monitor wells in and around in situ sites to provide samples and to permit frequent inspection of subsurface conditions. For further discussions of water impacts associated with in situ retorting, see 4.c of this section.

b. Tract C-b

(1) Demand - Conventional underground mining, using the room and pillar method, is considered as the most likely to be employed at Tract C-b. Such a method is expected to produce oil at the rate of about 50,000 barrels per day, and would require processing water at the rate of from 8 to 13 cubic feet per second (6,000 to 10,000 acre-feet/year). Table IV-15 shows the expected demand for water that a 50,000 barrel/day underground mine with surface processing might consume.

(2) Supply - Underground mining operations may be several hundred feet beneath the potentiometric surface of the water in the leached zone which underlies the Mahogany Bed. Maintaining the water level in the aquifer below the bottom of the mine could require large capacity pumps and many wells. Water pumped from the upper part of the leached zone might be of good quality and be used in plant operations, but water from the lower part of the leached zone may be extremely saline and present a disposal problem. The amount of water to be pumped will depend directly on the aquifer, its local fracturing and faulting characteristics, and competency of the strata in and overlying the zone to be mined. At the present time, it is expected that development will be initiated in the Mahogany bed. It is not yet known if water levels in the aquifers above and below this zone will need to be lowered to enable mine development, but local fractures and faults may permit excessive flow into a mine in the Mahogany bed. Should the inflow be minor, then bulkheading, pregrouting, progressive grouting, and overburden

Table IV-15.- Typical Water Consumed for an Underground Mine, 50,000 Bbl/Day Oil Shale Plant

	Acre-feet/year
PROCESS REQUIREMENTS	
Mining and Crushing	370- 510
Retorting	580- 730
Shale Oil Upgrading	1,460-2,190
Processed Shale Disposal	2,900-4,400 1/
Power Requirements	730-1,020
Revegetation	0- 700
Sanitary Use	20- 50
Subtotal	6,060-9,600
ASSOCIATED URBAN	
Domestic Use	670- 910
Domestic Power	70- 90
Subtotal	740-1,000
GRAND TOTAL	6,800-10,600
AVERAGE VALUE	8,700

1/ Water used is 20 percent by weight of the disposed spent shale.

Sources: Same as those used in Volume I, Chapter III, Section B.

dewatering and pumping may be employed to reduce the inflow of water. If a stable hydrological balance cannot be maintained between the upper and leached zone aquifers because of fractures in the Mahogany bed, it will be necessary to lower the water table in both the overlying and underlying aquifers.

(3) Supply-Demand Relationship - Based on the estimated aquifer characteristics,[1/] pumping water from both of the aquifers may result in a maximum initial rate as high as 40 cubic feet per second (29,000 acre-feet per year). This rate would gradually decline to about 18 cubic feet per second at the end of a 30-year period (Figure IV-14).

The complete demand-supply balance for a 50,000 barrel per day processing complex is given in Figure IV-15. The amount of water required is approximately one-half of that described for the larger surface mine development considered for Tract C-a. This system can be balanced if mine dewatering produces 10 to 14 cfs, a possible situation if the hydrologic balance across the Mahogany zone can be maintained by the mechanical means discussed above, under (2).

The maximum environmental impact will occur when both aquifers are pumped. That is, the quantity of water to be pumped will be greater and more of the water will be saline. For the purpose of this analysis, a maximum condition for excess water is assumed, that is, 40 cubic feet per second will be pumped initially. It is further assumed that the water would be of different quality at different times and different depths. As the quantity and/or

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1/ Assumptions: (1) Transmissivity = 5,000 gpm/ft; (2) Storage coefficient = 10^{-1}; (3) Pumping rate = 40 cfs.

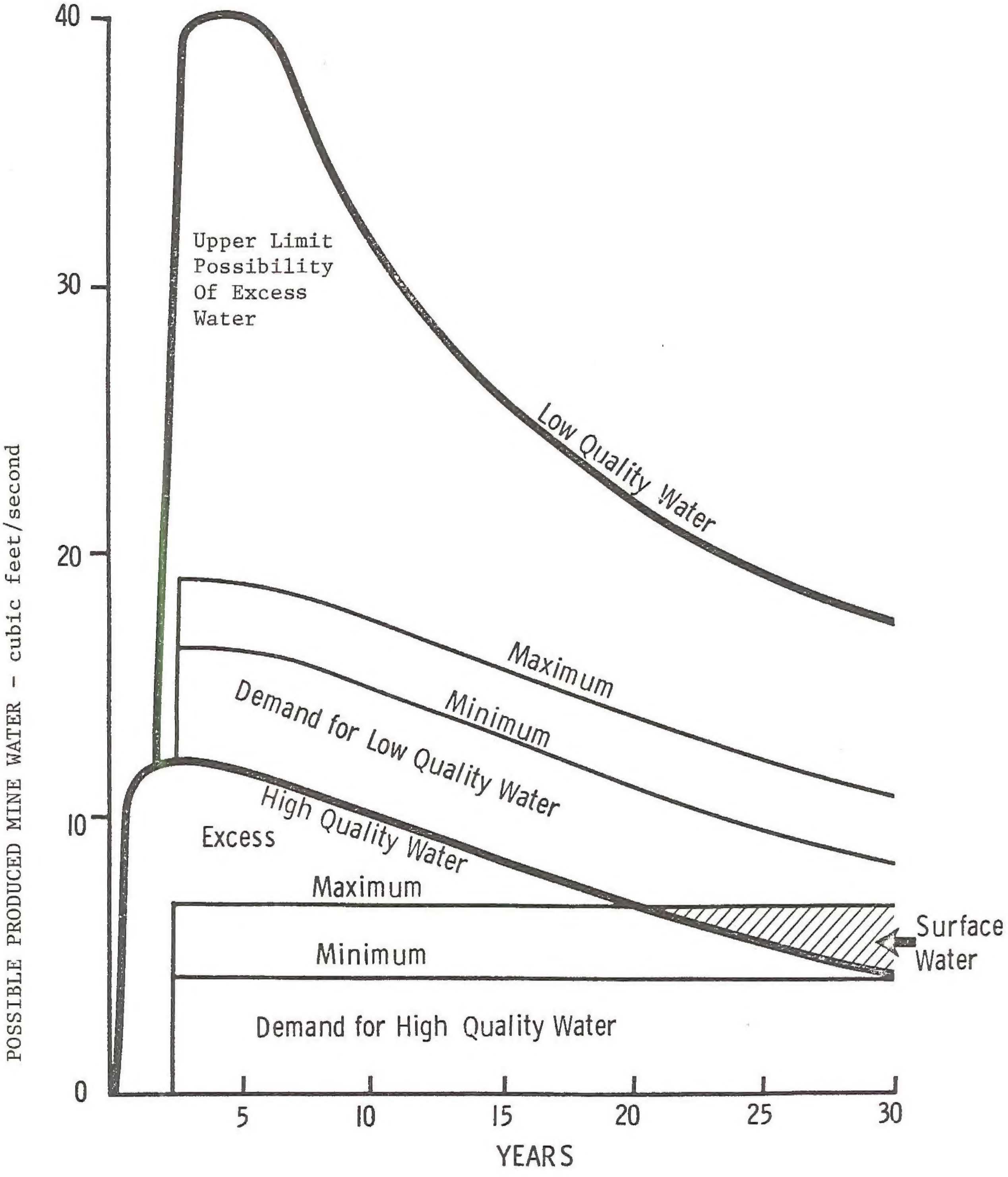

Figure IV-14. Water Demand - Supply Relationships for a Hypothetical Underground Mining Operation, Tract C-b.

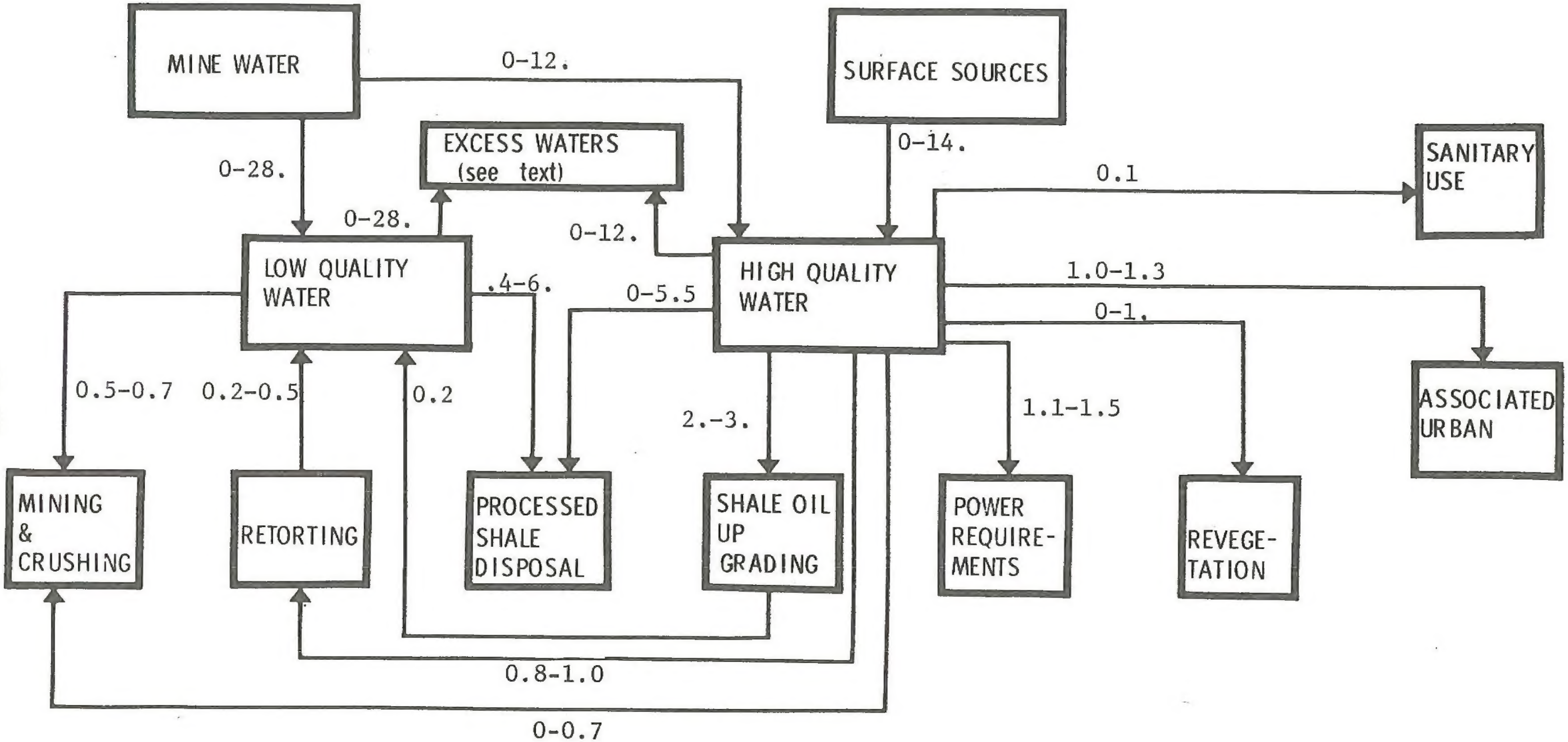

Figure IV-15. Demand and Supply for Water; 50,000 Bbl/Day Underground Mine, Tract C-b (cu ft/sec) (Assumes 40 cfs pumped initially, of which 12 cfs is of high quality water and 28 cfs is of low quality water)

quality of the mine water decreases, it is also assumed that surface water will need to be diverted in greater quantities as detailed in Figure IV-14.

As indicated above, a lower withdrawal rate may be possible with corresponding decrease in the amount of excess waters. Ideally, the rate at which the mine is dewatered would satisfy only the processing needs. This type of balance is possible, but sinking a mining shaft to the Mahogany bed may require much higher rates of water withdrawal than can be consumed initially. Precise quantification of the relationship between demand and supply will be possible only after actual operations are commenced.

(4) Impacts - Calculations similar to those for Tract C-a were made to estimate the decline in ground water levels in the vicinity of Tract C-b. Again, the calculations are based on a simplified assumption that pumping would continue at the maximum rate of 40 cfs throughout the 30-year life of the mine. A transmissivity of 5,000 gpd/ft was assumed. In actual operation, this maximum rate of withdrawal would probably decline to about 18 cfs by the end of the 30-year period.

The estimated maximum ground water decline for Tract C-b is presented in Figure IV-16, and the wells and springs surrounding this tract in Figure II-25. Little impact is foreseen on these wells and springs at a distance beyond 40,000 feet (Figure IV-16). Some 21 springs within a 30,000 foot radius of the assumed pumping center[1/] would be significantly reduced in flow, while 19 springs

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1/ A single source located at the center of the tract.

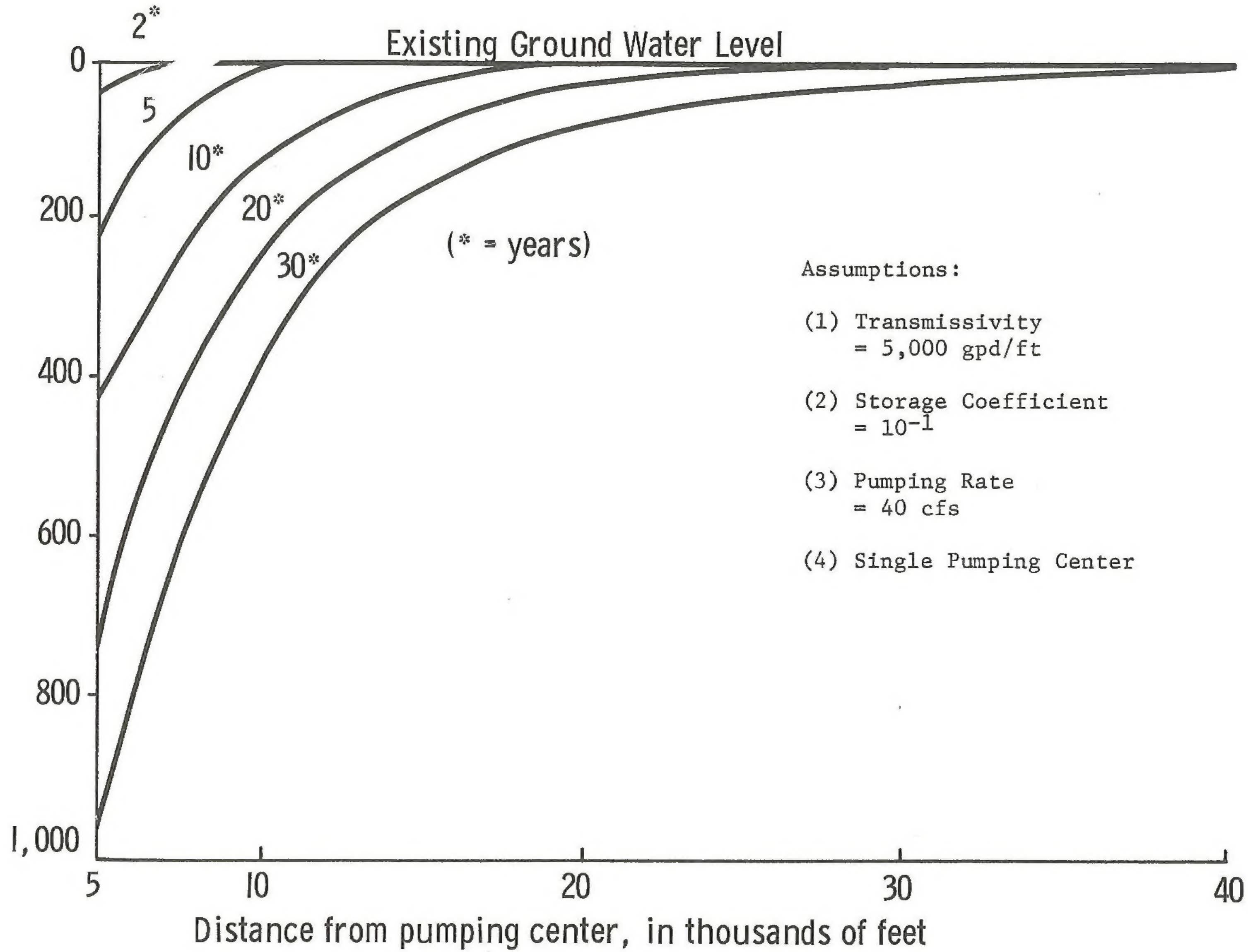


Figure IV-16.--Estimated Decline of Ground-Water Levels at Different Times and Distances From a Mine in Tract C-b.

at distances of 30,000 to 40,000 feet could experience reduced flows at the end of a 30-year period, depending on whether the springs are fed by perched water or by the regional zone of saturation. Five water wells 10,000 to 30,000 feet from the assumed pumping center would experience lowered water tables ranging from about 10 to 60 feet and 5 wells at a distance of from 30,000 to 40,000 feet would not be significantly affected.

Perennial streams within about 5 miles of the mine would be significantly affected if the maximum pumping rate (40 cfs) were maintained continuously for 30 years. If Piceance, Sulfur, Fawn, and Ryan Creeks are not augmented by release of good quality excess waters, they could experience reduced flows. The potential for sediment and mineral loading to these streams also exists (see calculations in Volume I, Chapter III, Section C).

Excess mine water may be released directly to Piceance Creek, treated and released, treated and reinjected, or left untreated and injected into the leached zone, as discussed previously for Tract C-a in Section B.2.a.(3) of this volume.

After mining by the room and pillar method has progressed sufficiently, part of the processed shale could be disposed of by backfilling the mine. Potential ground-water contamination problems could occur from minerals leached from the shale (see Volume I, Chapter I, SectionC.1.d.(2). The probability that large quantities

of minerals will be leached to Piceance Creek is low, but would constitute a long-term problem because of the potential salt-loading to Piceance Creek and the Colorado River system (for hypothetical impact calculations, see Volume I, Chapter III, Section C.5.a(3).

Surface subsidence is a potential problem in any mining operation and must be considered in view of the geology and hydrology of the Basin. Subsidence generally affects drainage patterns by altering the slope of streams which, in turn, create new patterns of surface erosion. At this site, severe subsidence effects on the streams (Little Scandard Gulch, Scandard Gulch, Cottonwood Gulch, Sorghum Gulch, West Fork Stewart Gulch, and Middle Fork Stewart Gulch) would not be expected because the stream channels have considerable slope and their gradient and direction would not be greatly changed if the channel were intercepted by surface subsidence. Backfilling of the mines with processed shale would reduce the possibility of subsidence.

As for all industrial development, stream and ground water pollution from accidentally spilled oil or other toxic materials may occur, but the frequency of this happening is not now known. These impacts would be in addition to the salt-loading discussed above.

Although this discussion has treated subsurface mining as the probable method of development of Tract C-b, it is also possible to develop this site by in situ methods.

Specific in situ process details are not known, but it is assumed that initial dewatering of the working strata will be

required. However, pressure would need to be maintained during the combustion process. This pressure would retard water movement into the retorting area, thus the total water volume produced during in situ processing is expected to be relatively small compared to the volume pumped from an underground mine development. Pressure increases could also cause organic materials formed in the retorting process to enter and thereby degrade ground water aquifers. Spent shale from the in situ process would be left in place and therefore would not require surface disposal. However, material (salts and hydrocarbons) which may be leached from this source would affect the quality of ground water and ultimately may reach and degrade Piceance Creek.

Fracturing across the Mahogany zone would facilitate upward movement of artesian water from the deeper leached zone, thus increasing the amount of water that would have to be removed to sustain the process. Fracturing and retorting would increase porosity and permeability and possibly alter existing hydraulic gradients. This could produce some long-range changes in the direction and rate of ground water flow. The processed shale remaining underground, being more highly fractured after retorting, would be more susceptible to subsequent leaching by ground water moving through the strata.

3. Utah Tracts U-a and U-b

a. Demand

The demand for water for a "unit" 50,000 barrel per day underground mine followed by surface processing has been detailed in Part 2-b above (Table IV-15). Demand for water would range from 6,800 to 10,600 acre-feet per year for this size processing complex.

In situ processing may also be employed at the Utah tracts. The demand for water for this processing option would range from 3,000 to 5,700 acre-feet per year as detailed in Table IV-16.

b. Supply

Based on the hydrologic analysis given in Chapter II, Section B.2.d, significant quantities of water are not expected to be available from ground water sources to support operations on the Utah tracts. Therefore, surface water sources would be required to support development and the adverse impacts associated with the management of excess water discussed previously for Tracts C-a and C-b will not be encountered.

The Utah Division of Water Resources presently holds a pending application (No.36979) for the appropriation of 350 cfs (250,000 acre-feet per year) of water from the White River, its tributaries and underground. Part of this could possibly be used by the oil shale industry but storage of flood water in impoundments would be necessary to assure a dependable year-round supply. A pipeline would be required to bring the required water from the White River to the tract.

Table IV-16.- Typical Water Consumed for 50,000 Bbl/Day In Situ Development

	Acre-feet/year
PROCESS REQUIREMENTS	
Shale Oil Upgrading	1,460-2,220
Power	730-1,820
Revegetation	0- 700
Sanitary Use	20- 40
Subtotal	2,210-4,780
ASSOCIATED URBAN	
Domestic Use	720- 840
Domestic Power	70- 80
Subtotal	790- 920
GRAND TOTAL	3,000-5,700
AVERAGE VALUE	4,400

c. Demand-Supply Relationship

The water balance for an underground mine-surface processing complex in Utah (Figure IV-17) does not include a supply of water from mine dewatering. Thus, it represents the other extreme to a similar complex that may be developed at the Colorado prototype Tract C-b (Part 2-b above), i.e., it is expected to be essentially a dry mine.

Although some water will be available from the retorts and the upgrading step, the majority of water requirements will need to be obtained from surface water supplies, probably the White River.

d. Impacts

During the initial development, sediment may be released to the White River via Evacuation Creek. This impact would usually be small and of short duration. Heavy, but infrequent, rains may also wash sediment and mineral matter into the river. The sediment yield for the area around Tracts U-a and U-b is 0.5-1.0 acre-feet per square mile per year (3), and the drainage area of the White River at Watson, Utah, is approximately 4,020 square miles (4). Thus, the natural yield of sediment from the drainage area is 2,010 to 4,020 acre-feet per year. Under the storm conditions assumed in Volume I, Chapter III, Section C.5.a.(4), the estimated sediment yield from each spent shale disposal site is 0.2-0.8 acre-feet per year. While this amount could underestimate long

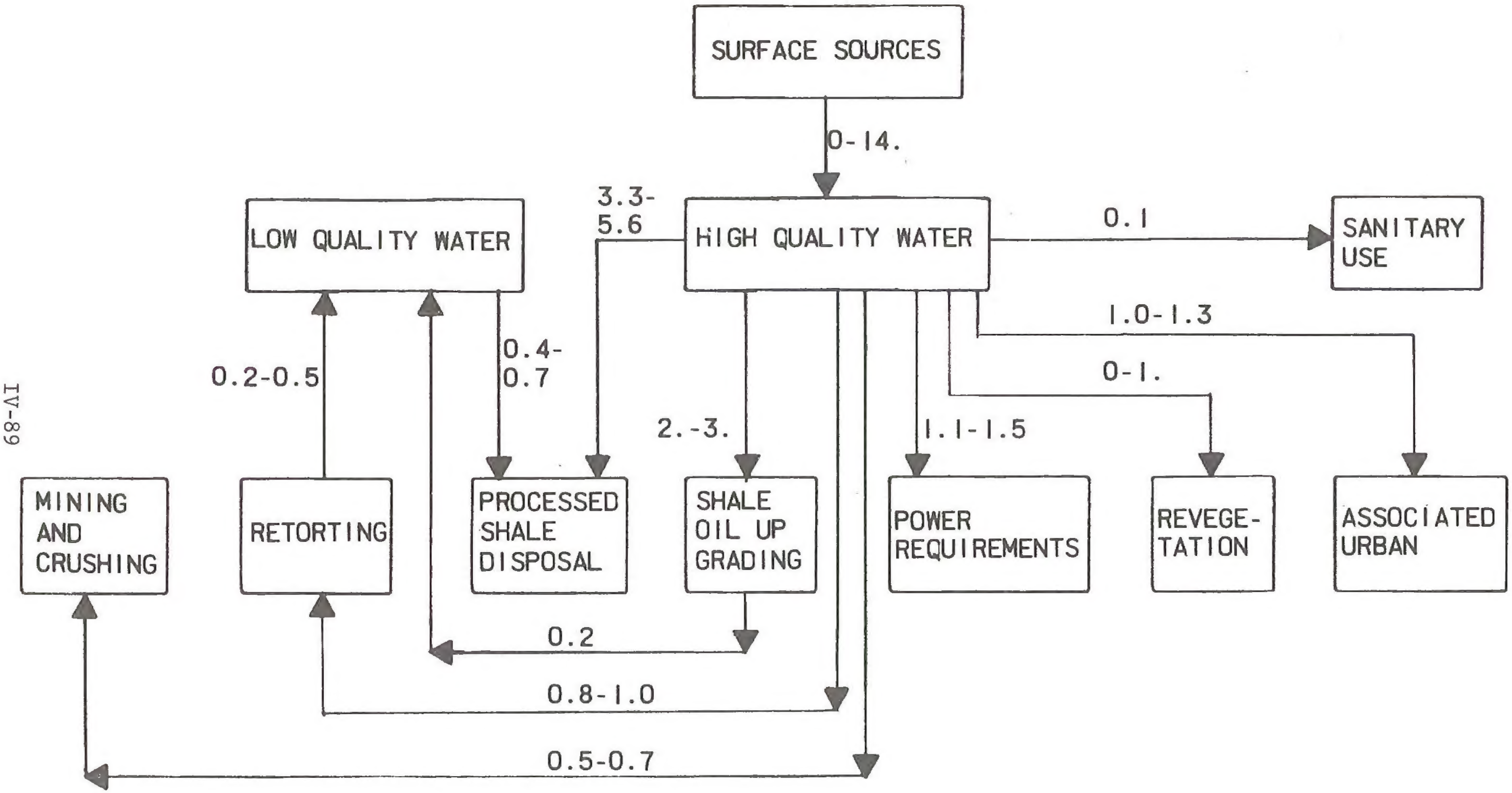


Figure IV-17.--Demand and Supply for Water; 50,000 Barrel Per Day Underground Mine, Tracts U-a and U-b (cu.ft. per sec)

term effects due to possible head cutting and channeling at the face of the spent shale pile, the impacts of sediment from these piles should be localized and minor when compared to natural sediment loads from the drainage area but would constitute additional loading to the White River.

The average salinity and salt load of the White River at Watson, Utah, are 450 mg/l and 990 tons/day, respectively (5). The estimated salt load from a spent shale disposal site under the assumed storm conditions is 2,400 to 5,500 tons (Volume I, Chapter III, Section C.5.(3)). Due to the increased flow from a storm of the assumed size, this added salt load would not necessarily lead to increased salt concentrations. (See Appendix A, Volume I, Chapter III). However, total loading would be increased by the amount received from the waste piles as a result of each storm. The impacts should be relatively minor unless the concentration of heavy metals or toxic materials entering the runoff from the spent shale piles becomes greater than a few parts per million. Any such impacts resulting from heavy metal or toxic material runoff should be limited to the area around the point of entrance into the White River and dowstream for an unknown distance where some loss of aquatic life would probably occur.

Degradation of the ground water could result from oil spillage and other similar accidents but would be expected to be short-lived and of local significance. The frequency and the amounts of materials involved in such accidents are not quantifiable at the present time.

Impoundments to trap sediments at the base of disposal piles or to store water would disturb the land and vegetative cover in the vicinity of the tract where constructed and would represent the largest potential for surface water degradations should any fail due to a flood or an accident.

Subsidence caused by pillar collapse in the underground mine could change local surface water drainage patterns over the extreme long term. Backfilling the mining rooms with spent shale as soon as work in an area is completed would reduce or eliminate the possibility of such subsidence, but the effects on ground water are uncertain.

4. Wyoming Tracts W-a and W-b

a. Demand

Both of these adjacent tracts would probably be developed using an in situ method. Oil production at the two sites may reach a total rate of 50,000 barrels per day. Consumptive use of water is given in Table IV-8 above, and for processing would range from 3 to 6.5 cubic feet per second, 2,200 to 4,800 acre-feet per year.

b. Supply

A few gallons per minute of fresh water are available from the shallow aquifer on the tracts, but shallow wells on the tracts could not supply the needs of the operation. Some water supplies might be obtained from deeper aquifers, but few data are available from which to predict the amount and quality of deep water that might be found.

Pumping water from the deeper aquifers and nearby reservoir storage of this water or surface water could partially meet the projected annual needs. However, the water required for this development is available from either the existing Fontenelle or

Flaming George Reservoirs on the Green River. Utilizing these sources would require construction of a pumping plant and pipeline to bring the required water from the river to the tracts. The required water needs and associated supply are illustrated in Figure IV-18.

c. Impact

While information is limited concerning the impact on water for an in situ operation, it probably will be necessary to dewater the subsurface oil shale zone. However, it is expected that little water will need to be pumped, i.e., less than a few thousand gallons per minute (see Chapter II, section A.5.b. of this Volume).

Information on the effect of in situ operations is available from pilot scale tests which have been and are currently being conducted by the U.S. Bureau of Mines, Laramie Energy Research Center (6). These tests have been conducted about 40 miles to the northwest of Tracts W-a and W-b.

The in situ experiment commenced in September of 1970 and continued for 50 weeks. Water samples were taken for chemical analysis. The dissolved solids content in the water taken from wells approximately 200 feet from the burn zone was about 500 ppm at the beginning of the experiment. The dissolved solids of water from these core holes increased to about 20,000 ppm after the experiment and then began to decrease. The increase in dissolved solids content was observed in the core hole water (200 feet from the ignition well)

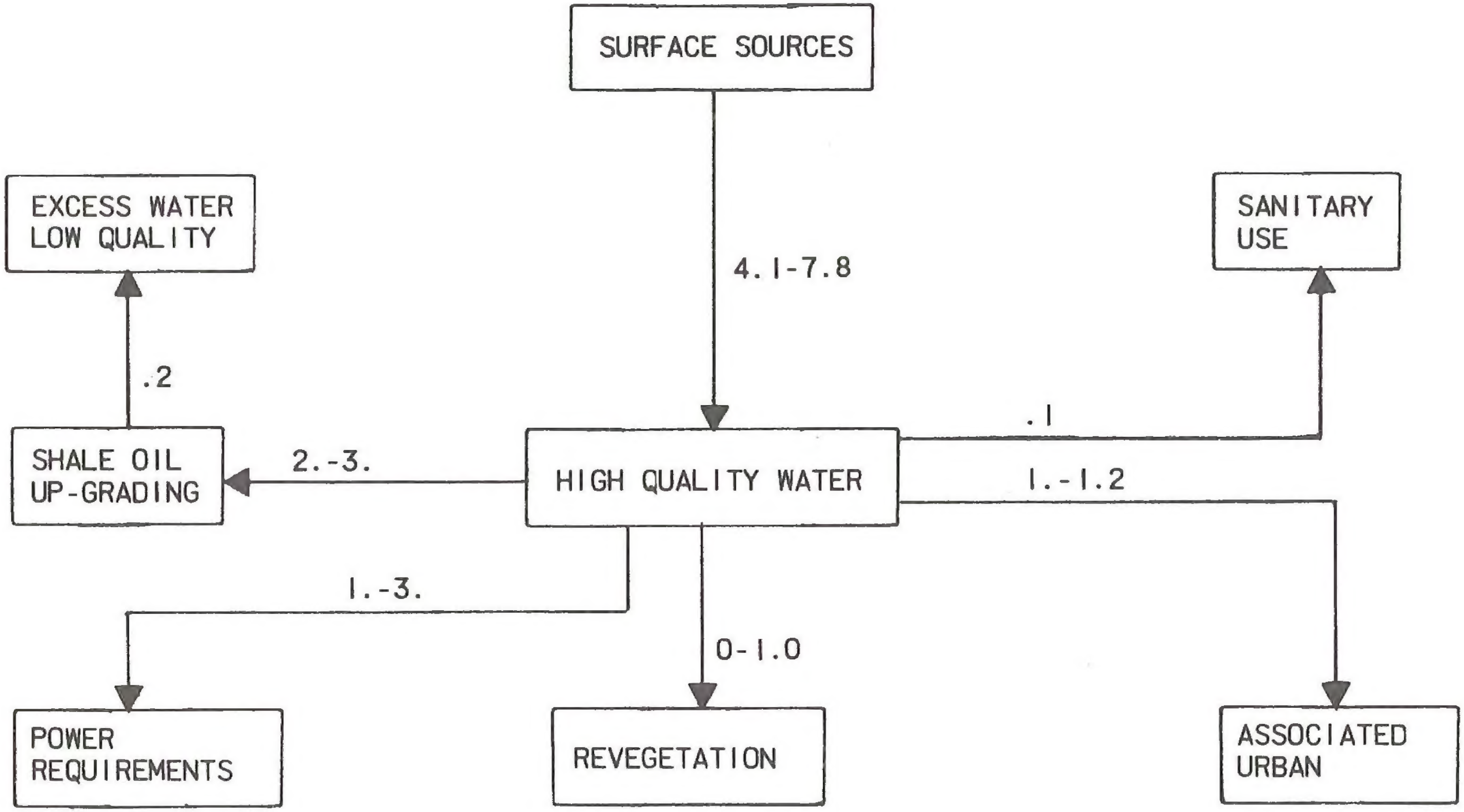


Figure IV-18.--Demand and Supply for Water; 50,000 Bbl/day In Situ Operation, Tracts W-a and W-b (cu.ft.per sec)

within 2 months after the end of the 50-week experiment. Indications from this experiment showed that, at least in that particular in situ experiment, contamination of ground water was confined to the area of the retorting and that ground water moved very slowly. The data from this small pilot demonstration cannot, however, be directly applied to the effects that may result from commercial in situ operation outside W-a and W-b. Still to be determined is the amount of dispersion of the saline waters, absorption of ground waters in the spent shale, leaching of the minerals from the spent shale, and the movement and possible discharge of such waters to the surface.

While the amount of saline water may not be nearly as great as that produced from mine dewatering, it can require treating or disposal, as was described in Volume I, Chapter III, Section C.4.

Due to the temperatures required to sustain underground combustion, as would be the case for an in situ operation, the produced water temperature may be increased. However, in the Wyoming experiment, the temperature in the observation water wells was not observed to rise higher than 44° F (about equal to the mean annual surface temperature).

Another study was conducted by Aerojet-General Corporation in the fall of 1970 for the U.S. Bureau of Mines, which included mapping the relative surface temperature distribution for the in situ area near Rock Springs, Wyoming. The surface temperature survey was performed to determine the distribution of thermal energy

in the vicinity of the site. Results of the surface temperature measurements showed that temperature anomalies did occur. These generally corresponded to the well pattern area and were confined within a 50-foot radius of the producing wells. The depth to the oil shale zone being retorted was about 80 feet. The background or mean relative surface temperature was approximately 43° F. As a result of this study, localized thermal areas of 46° F to 64° F were evident. Twenty-four of the features were greater than 46° F, 17 were greater than 50° F, and eight were greater than 54° F. Most increases were in close proximity to the well casings; however, about 6 of the thermal increases were not, thus suggesting the possibility of venting or upward migration of thermal energy along fractures in the overburden. These anomalies were still within a distance of 50 feet from the wells. It should be emphasized, however, that the test holes were less than 100 feet deep.

There is no overburden in the oil shale bearing segment of the Laney Member near the western margin of the prototype Tracts W-a and W-b. The overburden increases abruptly eastward to a maximum of 2,400 feet and averages 600 feet. With this potentially greater overburden, the thermal conductivity up the casing or through the surrounding formations can retard and insulate the heat flow which could result in less thermal effects being observed at the surface of the ground than was the case at the experiment near Rock Springs.

The in situ process eliminates most of the common problems of storing overburden and spent shale. However, surface disturbance during construction of access roads and drilling sites poses potential pollution problems as the result of sediment being washed into Sand Creek to Shell Creek and to the Green River by way of Vermillion Creek. In situ processing may also cause solvents or oils to escape into the aquifers if not contained. Spent shale left in place could also yield organic and inorganic contaminants to ground water after the in situ processing is completed and dewatering is stopped.

Other possibilities exist for stream pollution from mining on the tracts. These include accidental spillage of oil from pipelines or tank failures, land erosion and consequent stream sedimentation from construction of pipelines, roads, and plant facilities, and possible waste discharge necessitated by the breakdown of waste treatment or disposal facilities. Any contaminants reaching the surface water in significant quantities would add to the salinity problems of the Colorado River watershed.

C. Impact on Air Quality and Noise Impacts

1. Air Quality

As noted in Volume I, Chapter I, of this Environmental Statement, the primary sources of potential air pollution from oil shale processing are the following: particulates from mining, crushing and grinding, screening, and general solid materials handling; burning of retort off-gases from either surface or in situ retorting, or of refinery off-gases from shale oil upgrading; burning of any supplemental fuels, for example, for on-site power generation; and possible air contamination due to surface vehicles and traffic. The major potential pollutants in gaseous emissions from the plant include sulfur dioxide, nitrogen oxides, and to a much lesser extent, possible small residual concentrations of light hydrocarbons and carbon monoxide.

The extent of potential air quality changes from these various sources have been reviewed in Volume I, Chapter III, Section C. As applied to the contemplated operations on each of the six selected tracts, the following on-site residual emissions could occur from a typical 50,000 barrel per day surface retorting plant with accompanying upgrading facilities: airborne dust, about 1 ton per day; sulfur dioxide, 49 to 93 tons per day, depending on process; and nitrogen oxides, 4 to 6 tons per day. These emission rates would meet applicable Federal and/or State standards.

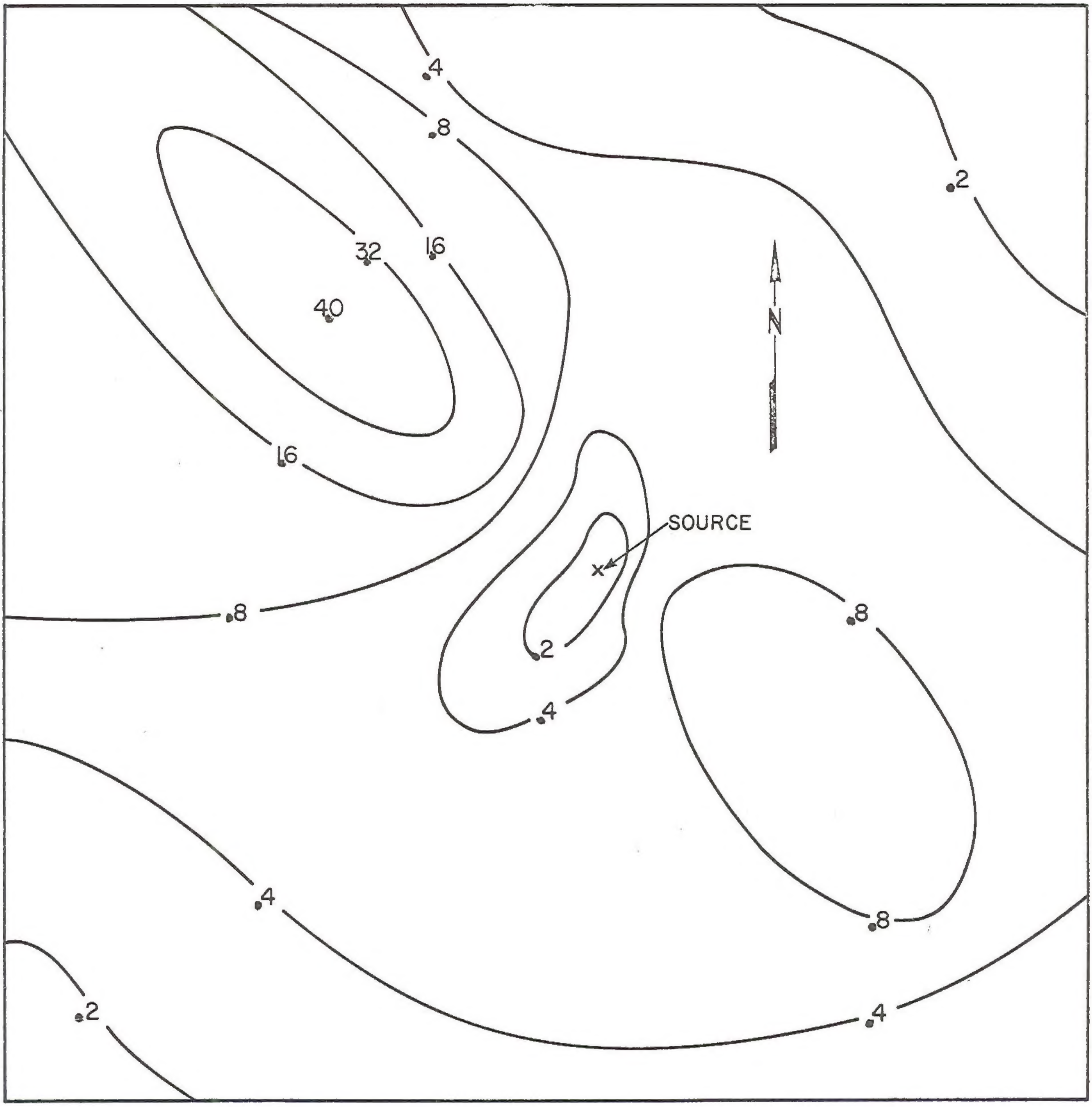
Atmospheric temperature inversions are likely to be encountered on both the Colorado and Utah tracts and will influence effective

stack gas heights and resultant dispersion patterns at these lease tracts. Such inversions are not expected at the Wyoming tracts.

The dispersion of pollutants from a typical (50,000 barrel per day) plant site subjected to inversion conditions has been assessed using a mathematical model and is discussed in detail in Volume I, Chapter III, Section C. The model calculated the dispersion of sulfur dioxide because its emission and dispersion is most critical to meeting air quality standards.

In the mathematical model, the stack gases from burning the retort off-gases from an indirectly heated retorting process as fuel were selected for illustration, since this process may well be the first to attain commercial-scale production. It was assumed that only 90 percent of the sulfur (as hydrogen sulfide) in the retort gases would be removed, although conventional MEA (monoethanolamine) scrubbing technology for hydrogen sulfide may attain up to 99.5 percent reduction.

The mathematical model was used to determine ambient ground level distributions of sulfur dioxide as a function of distance from source, stack height, and assumed level of control. Typical results are shown in Figure IV-19, for an 800 foot stack height and 90 percent SO_2 control (reproduced from Volume I, Chapter III). Under these conditions, the maximum ambient concentration of SO_2 is 4 ug/m^3, and occurs at a point approximately 10 miles northwest of the stack. This maximum concentration is within national ambient air quality standards for SO_2 and also within State standards.



ASSUMPTIONS:

Indirect heated retort (50,000 barrels per day
90 percent control of sulfur
Effective stack height 800 feet

SCALE - 1 inch = 20,000 feet

Figure IV-19.--Annual Average Ground-Level Concentration of Sulfur Dioxide
(micrograms per cubic meter)

At the 800 foot stack height, the study indicated that several 50,000 barrel per day plants could be located as close as 15 miles to one another along the prevailing southeast-northwest dispersion axis, and still meet National Ambient Air Quality Standards. More efficient sulfur removal than the 90 percent used for this study would permit lower stack heights and somewhat closer plant spacings.

Possible particulate emissions from proposed oil shale operations on the tracts in Colorado, Utah, and Wyoming have been considered for interference with forage crops and, in particular, alfalfa and its sensitivity to SO_2 concentrations.

Wyoming Tracts W-a and W-b lie in an area of generally westerly winds and the possible particulate emissive concentration zone of SO_2 involves no irrigated farmlands that support agricultural stands of any magnitude.

Utah Tracts U-a and U-b lie in an area of prevailing winds from the southwest and no irrigated farmlands that support vegetative stands of any magnitude are known to exist in the area of possible SO_2 concentrations or particulate emissions.

Colorado Tract C-a lies in an area of prevailing winds that develop a southeast to northwest dispersion axis with a maximum SO_2 concentration zone some 10 miles northwest of the source. A 100,000 barrel per day plant will produce approximately two times the amount of ambient pollutants than described in the general discussion above. Consideration of the location of Tract C-a indicates that possible concentrations of SO_2 would not interfere with irrigated farmlands that support vegetative stands of any

magnitude. The town of Rangely may be subject to some adverse air quality effects including low level odor, under sustained inversion conditions. The effects on Meeker would be similar under prevailing southwest winds.

Colorado Tract C-b has a possible particulate emission concentration area along the Piceance Creek Drainage in the general vicinity of the confluence of Ryan Gulch and Piceance Creek.

The scattered grasslands along Piceance Creek are estimated to contain some 20 percent alfalfa. Introduction of alfalfa develops a seasonal cycle of initially alfalfa with seasonal progressions of alfalfa and grasses to grasses provide the forage crops that are grown in the Piceance Creek Drainage. Alfalfa is a crop sensitive to damage by sulfur oxides and some losses may occur, particularly under sustained inversion conditions.

The residual pollutants are expected to be within applicable air quality standards and the maximum ambient concentration of pollutants would be outside the tract area itself. Except for accidents or sustained periods of inversion, significant effects are not expected as explained in Volume I, Chapter III, Section C, which contains a complete discussion of potential adverse effects on humans, fauna, and vegetation.

2. Noise Impacts

During the initial exploration and construction phases on any of the selected tracts, the noise resulting from diesel trucks, compressors, mixers, drills, and other general construction machinery and vehicles might cause certain wildlife on or near the tract to move to other locations.

Once commercial-level operations are attained at each tract, it can be expected that the general noise level on each tract would increase over that associated with construction. Conventional surface mining would require power shovels, earthmovers, conveyors, and grinders that would generate considerable noise on or near the tracts. Similar problems, but with less intensity, would occur with underground mining techniques. Blasting, perhaps three times per day per operation, would create a routine disturbance and annoyance of local ranchers and wildlife. Less than 50 people live within 5 miles of any of the prototype tracts. Retorting and upgrading processes would emit noises quite similar to those for petroleum refinery operations, although the level of such noise would depend on the specific processes employed. For the in situ extractive processes, underground blasting, compressors, pumps, etc., would provide obvious noise sources.

A general increase in the noise level of all residential areas associated with each of the tracts can be expected, as wage earners, supporting personnel, and their families move into population centers and transform less populated communities into those with the characteristics of more urban environments.

In general, annoyance and disturbance of human and wildlife on and near the tracts caused by noise would be similar to that occurring on and near conventional large-scale construction and industrial plant operations. It is also likely that noise resulting from in situ operations (which is most likely on Tracts W-a and W-b) and from underground operations (C-b, U-a and U-b) would be considerably less than that which would be associated with surface mining operations on Tract C-a. Even in the case of surface development, the noise would be increasingly muffled as the pit floor is deepened.

D. Faunal Impacts

1. General

The following discussion is directed to tract-specific impacts on faunal resources resulting from oil shale development on the six proposed prototype tracts. Impacts on fauna of both a localized and regional nature have already been discussed in Volume I, Chapter III, Section E of this analysis.

2. Colorado Tracts

a. Tract C-a

The 16 miles of trail and presently unpaved road from the Piceance Creek Highway to the proposed tract would probably be widened and paved. This will result in a direct loss of habitat. This road improvement would lead to additional impacts on wildlife such as increased traffic noise and increased road-kills. Unless specifically regulated, hunting pressure and other human uses would be locally increased resulting in an expanded game harvest with a subsequent population reduction. The loss of the primitive characteristics currently existing on and in the vicinity of Tract C-a through industrial development will result in a significant adverse impact affecting the welfare of existing fauna. Contributing to anticipated physical and visual impacts are road pipelines, transmission lines, directional signs, and air traffic facilities.

Human activities accompanying construction operation, e.g., vehicular traffic, noise from construction equipment and

blasting, generation of dust and smoke, would also cause a net effect of stress and disturbance to existing faunal behavior and activity patterns. Although the impact of each particular disturbance in itself might be relatively small, the compounded net effect over the life of the lease at Tract C-a would be a chronic disturbance and would result in a displacement of wild animals from the tract vicinity. Most small animals would, by nature, avoid such areas only during periods of disturbance. However, other species, such as mountain lion, elk, and the endangered peregrine and rare prairie falcon would be intolerant, with portions of the tract vicinity being completely lost to them as suitable habitat. Species which would be most affected by disturbances include mountain lion, bear, elk, mule deer, bobcat, sage grouse, blue grouse, hawks, owls, and migratory birds. Such habitat loss will result in increased competition for available food and space, resulting in general population reductions.

If an airstrip for light planes was constructed on or near the site and regular air traffic was to commence, the resulting noise would cause localized disturbance of mule deer, wild horse, and other animals. In addition, mule deer and other species would be vulnerable to stress caused by aircraft along low-level flight paths. The extent of such aerial disturbance of wildlife at Tract C-a would be dependent upon the volume of air traffic. It is expected

that such flights will be infrequent. Nevertheless, repeated disturbance could cause the death of weakened animals during winter and early spring months.

Surface mine development of Tract C-a could result in a maximum disturbance of approximately 6,650 acres over a 30-year timeframe, including 1,400 acres within the boundary of the tracts; 4,850 acres for offsite disposal of processed shale and overburden; and 400 acres for access roads and utility and pipeline corridors. Should some of the processed shale be disposed of through backfilling, disposal acreage needs offsite would be reduced to 2,800 acres.

Preferred browse species for mule deer are bitterbrush, mountain mahogany, and serviceberry. Oil shale operations can be expected to destroy about 5,180 acres of habitat containing these species (3,360 acres with backfilling). Of this amount, about 900 acres will be on-tract. Sage brush is utilized extensively as forage by deer and elk during critical winter-use periods and is an important constituent in yearlong sage grouse habitats. Of this type, some 2,260 acres will be affected (1,900 acres with backfilling), about 790 acres will be on-tract. Mountain swales, which include bluegrass, wheatgrass, wildrye, and associated wet seeps, provide suitable habitat for sage grouse during spring and summer months and could also provide habitat for elk. Some 450 acres will be destroyed (370 acres with backfilling), with 140 acres being on-tract. A total of 2,300 acres of rough, broken land will also be affected

(1,270 with backfilling). South-facing slopes in this area commonly provide the forage and snow-free slopes essential to deer survival during critical winter months. They also contain saltbush, a key food species for chukar partridge. Most of the habitat destroyed is also suitable for jackrabbits and cottontails, important food items for wintering golden eagles. Similarly, habitat for rodents and other small animals, prey species for raptors and predatory mammals such as the coyote, bobcat, and fox would be lost.

The impact of food and cover loss upon the fauna would occur principally in the loss of production capacity for the disturbed acres. This loss would in turn be reflected in lower populations of animals. As shown by McKean and Bartmann (7), the loss of surface vegetation on each section (640 acres) within areas of good deer habitat can result in a potential reduction in carrying capacity for up to 50 mule deer. Thus, removal of winter browse would result in a corresponding reduction in mule deer numbers. The permanence of such a reduction would be dependent upon the time required for and success of reestablishing useful wildlife food and cover.

Due to the physical effects of both the mining operations and the anticipated possible use of ground water for processing and development activities, it is anticipated there will be some lowering of water tables affecting springs and seeps in the tract vicinity. A total of 37 springs located within a 40,000 foot radius of Tract C-a will be affected. However, some of the springs are fed by perched water and would not be affected. The degree of

effect will range from no effect to lowered flows to complete drying. Loss of such features would result in a disruption of the natural plant-animal complex associated with each, including the related distribution of existing wildlife, cattle, and wild horse populations.

Areas stripped of natural cover would become vulnerable to wind and water erosion, until stabilized through revegetation or other means. Available information does not permit quantitative predictions of the extent of erosion on and in the vicinity of Tract C-a. However, an estimated 6,650 acres of land surface with erosion potential varying from very low to very high would at one time or another be exposed.

Historically, mule deer have summered each year on the higher elevations of the Cathedral Bluffs-Roan Divide near Tract C-a, and then crossed the tract in order to winter in the Piceance, Yellow Creek, and White River drainages. Oil shale construction and operation activities both on- and off-tract, road traffic, fences and other obstacles, and increased human use on Tract C-a would be expected to result in rerouting of this traditional migration pattern.

It would be reasonable to expect some loss of birds, particularly hawks and eagles, which are vulnerable to shooting.

Vegetation adjacent to dirt roads and trails, stockpiles, and construction sites would be regularly covered with dust. This would constitute a minor type of habitat loss, since such vegetation would lose its wildlife food and cover value only until washed off by subsequent rains.

In the event that an accidental oil spill were to occur through breakage of the underground oil pipeline or oil storage facilities, vegetation and fish habitat exposed to the oil would, for all practical purposes, be lost until restored by natural progression. The prototype operations would have the potential to degrade water quality, through the contribution of salts and toxic substances, including oil, to surface waters, and from siltation resulting from both on-and off-tract construction activities. Significant amounts of aquatic habitat and associated aquatic life do not exist on Tract C-a. However, they do exist downstream in trout ponds on Ryan Creek, in the White River and seasonally in intermittent Yellow Creek. Species which would be affected include trout, suckers, shiners, and associated organisms.

It has not been documented that any threatened species of fish and wildlife reside or breed on Tract C-a per se. However, Table II-24, a list of birds and mammals of Colorado Wildlife Management Unit 22 (which embraces Tract C-a), includes peregrine falcon (endangered), prairie falcon (a threatened species likely to become endangered), and a number of species whose status is undetermined, including the ferruginous hawk, prairie pigeon hawk, osprey, western burrowing owl, Columbian sharp-tailed grouse, and long-billed curlew. Therefore, it must be assumed that individuals of these species utilize Tract C-a and its vicinity as an integral part of their range, and that the area will be lost as a habitat for them because of habitat destruction and disturbance factors both on- and off-tract. The permanence and degree of loss will

depend on successful reclamation and revegetation with suitable food and cover species for these birds and/or their prey.

b. Tract C-b

This tract is primarily suited for underground room and pillar mining. This development process will result in a maximum disturbance of 2,210 acres over a 30-year timeframe, including 1,110 acres within the boundary of the tract; 900 acres for off-site disposal of processed shale, and about 200 acres for access roads and utility and pipeline corridors.

In the event the in situ technique is selected, on-tract surface disturbance will amount to 1,035 acres, plus 600 acres for roads and utility corridors largely located off-site.

Destruction of wildlife habitat containing preferred mule deer browse species (bitterbrush, mountain mahogany, and serviceberry) as a result of underground mine development can be expected to approximate 1,600 acres (800 acres with underground disposal). Of this, 120 acres would be on-tract. The loss of sage grouse habitat would amount to about 1,090 acres (530 acres with underground disposal). Of this, 800 acres would be on-tract. Mountain swale (which include bluegrass, wheatgrass, wildrye, and associated wet seeps) are important to sage grouse and could provide habitat for elk. Some 195 acres will be destroyed (85 acres with underground disposal) of which 5 acres are on-tract. Most of the area to be disturbed is suitable for jackrabbits and cottontails, a major food item for the wintering golden eagle. Similarly, habitat for rodents and other small animals, prey for raptors and predatory mammals would be lost.

In the event the in situ method is selected, direct losses of usable habitat for mule deer and elk would approximate 1,200 acres and for sage grouse, 810 acres. Losses of habitat for other animals mentioned above would be proportionally smaller than those associated with underground mining development.

As with Tract C-a, it has not been documented that any threatened species of fish and wildlife reside or breed on Tract C-b per se. However, Table II-24, a list of birds and mammals of Colorado Wildlife Management Unit 22 (which embraces Tract C-b), includes peregrine falcon (endangered), prairie falcon (a threatened species likely to become endangered), and a number of species whose status is undetermined, including the ferruginous hawk, prairie pigeon hawk, osprey, western burrowing owl, Columbian sharp-tailed grouse, and long-billed curlew. Therefore, it must be assumed that individuals of these species utilize Tract C-b and its vicinity as an integral part of their range, and that the area will be lost as habitat for them because of habitat destruction and disturbance factors both on- and off-tract. The permanence and degree of loss will depend on successful reclamation and revegetation with suitable food and cover species for these birds and/or their prey. The total impacts resulting from oil shale development and operations will include additional accessibility with accompanying human use; increased potential for hunting pressure with subsequent reductions in game populations; some loss of the tract's primitive qualities; disturbance of behavior and activity patterns of wildlife; loss of both on- and off-tract habitat of intolerant species, such as

mountain lion, elk, and peregrine and prairie falcon; aerial disturbance of mule deer and other animals in the event an airstrip were constructed; both on- and off-tract reductions in wildlife food and cover with a corresponding reduction in animal populations; the drying up or reducing the flow of 21 springs and seeps, unless fed by perched water, within a 40,000 foot radius of Tract C-b with a corresponding loss and/or shift in vegetation and relocation of animals in search of water and preferred foods; a minor loss of birds, particularly hawks and eagles, usually through contacts with power distribution lines and indiscriminate shooting; the potential for accidental oil losses with adverse impacts upon vegetation and animals, such as direct mortality and relatively long-term habitat degradation; and the potential for introduction of salts, toxic substances, and silt to the White River with accompanying losses and population shifts in aquatic biota.

Expected impacts on Tract C-b will be somewhat less severe than with Tract C-a because existing paved roads already bring human disturbance closer to Tract C-b. Further, the tract is not located where obstructions to major mule deer migration routes might occur.

3. Utah Tracts, U-a and U-b

Direct impacts on faunal resources resulting from oil shale development include reductions in both on- and off-tract wildlife food and cover with a corresponding reduction in animal populations;

the potential for accidental oil losses with adverse impacts upon vegetation, fauna, and aquatic habitat such as direct mortality and relatively long-term habitat degradation; and the potential for introduction of salts, toxic substances, and silt to the White River with accompanying losses and population shifts in aquatic biota. This would include fishes such as catfish, brown bullhead, and suckers, along with members of the aquatic food chain.

Indirect impacts include additional accessibility with accompanying human use; the potential for increased hunting pressure with subsequent reductions in game populations; some loss of primitive qualities; disturbance of behavior and activity patterns of wildlife; loss of both on- and off-tract habitat of intolerant species such as mountain lion, elk, and peregrine and prairie falcons; aerial disturbance of mule deer and other animals in the event an airstrip were constructed; and a minor loss of birds, particularly hawks and eagles, usually through contacts with power distribution lines and indiscriminate shooting.

Both Utah tracts are best suited for underground mining. This method would result in the disturbance of about 2,210 acres over a 30-year period (1,090 acres if underground disposal of part of the processed shale is employed). An additional 200 acres would be required for access roads and utility and pipeline corridors.

In the event the in situ technique is selected, surface disturbance would approximate 8,100 acres, plus 600 acres for roads and utility corridors.

Underground development and processing would destroy wildlife habitat containing preferred mule deer browse species (bitterbrush, mountain mahogany, and serviceberry). It is estimated that this would amount to about 1,300 acres (650 acres with underground disposal). The loss of sage grouse habitat would approximate 30 acres and 670 acres of habitat suitable for chukar partridge will be lost (340 acres with underground disposal). Much of the habitat on both tracts is suitable for jackrabbits and cottontails, which are the main food item for wintering golden and bald eagles. Similarly, habitat for rodents and other small animals, which are prey for raptors and predatory mammals, would be lost.

In the event the in situ method is selected, direct losses of habitat suitable for mule deer would approximate 5,600 acres, for sage grouse, 500 acres, and for chukar partridge, 2,200 acres. Losses of habitat for other animals mentioned above will be proportionately larger than with the underground mining method.

Proposed oil shale operations will result in the disruption of normal distribution and behavior patterns as well as the elimination of habitat essential to bald and golden eagles which commonly winter in the vicinity. Golden eagle nesting sites will also be adversely affected. Although not specifically documented, the use of habitat on oil shale tracts by a number of endangered or status undetermined species, including the peregrine falcon, prairie falcon and western burrowing owl is likely, and some of their habitat will be lost through anticipated development. The Colorado River squawfish (endangered), and the hump-backed sucker

and bony-tail chub (status undetermined) may be lost from the White River below its confluence with Evacuation Creek if accidental releases of toxic materials were to occur.

4. Wyoming Tracts, W-a and W-b

The direct impacts on the faunal resources of W-a and W-b as the consequence of in situ development include reductions in both on- and off-tract wildlife food and cover with a corresponding reduction in animal populations. In the event that accidental losses of oil, other toxic materials, and/or sediments were to reach Vermillion Creek and the Green River, some of the aquatic organisms and their habitat may be lost. Of particular significance is the important trout fishery which has been established in the Green River.

Indirect impacts of oil shale operations include additional accessibility with accompanying human use; the potential increase in hunting pressure with subsequent reductions in game populations; some loss of the tracts' primitive qualities; disturbance of affecting the normal behavior and activity patterns of wildlife; loss of both on- and off-tract habitat of intolerant species such as mountain lion, elk, and peregrine and prairie falcons; aerial disturbance of mule deer and other animals in the vent an airstrip were constructed, and a minor loss of birds, particularly hawks and eagles, usually through contacts with power distribution lines and indiscriminate shooting.

It is assumed that the in situ method would be used on both of the Wyoming tracts. This development method would result in disturbance of about 6,700 acres over a 30-year period, plus an additional 600 acres for access roads, pipelines and utility corridors.

Losses to prime antelope habitat including sagebrush, mountain mahogany, and saltbush associations would amount to about 7,200 acres. Losses of potential sage grouse habitat are also estimated to be 7,200 acres. About 5,500 acres of mule deer habitat will be lost. Much of both tracts provide habitat for the jackrabbit and other small mammals which are preyed upon by the wintering golden eagle and other raptors. Habitat for these small mammals would be lost.

Information provided by the Wyoming Game and Fish Commission shows that several threatened wildlife species occur on or in the vicinity of Tracts W-a and W-b. These include peregrine falcon (endangered), prairie falcon (a threatened species likely to become endangered), and the ferruginous hawk and western burrowing owl, the status of both being undetermined. The peregrine falcon has nesting sites in the vicinity of the tracts. In addition, four more species of undetermined status, the mountain plover, snowy plover, prairie pigeon hawk, and long-billed curlew, range in the area and can be expected to occur on the tracts at least on an intermittent or transient basis. While in situ extraction can be expected to be permanently destructive of less acreage than surface mining, sizeable direct and indirect habitat losses affecting

these key species can be expected on both tracts. The degree and permanence of loss will depend on successful restoration and revegetation with suitable food and cover species for these birds and/or their prey.

E. Impacts on Grazing

1. Colorado Tracts

Development of Tracts C-a and C-b would affect grazing by removing land from grazing use, by disrupting livestock travel routes, and possibly by loss of watering facilities.

Only the land actually occupied by the mining operations, the processing plant, waste disposal and related facilities would be removed from grazing use. Thus, the extent of grazing loss would depend upon the mining method used and the rates and success of the rehabilitation measures.

The following tables indicate the reduction in grazing use that would be expected from four typical development methods.

Tract C-a

Operation	Total Acres Affected	Average Area Lost to Grazing Acres/yr.	Average Grazing Loss AUMs'/yr	30-yr Accumulative Total AUM Loss
Open Pit	6,650	3,000	353	10,590
Open Pit (w/backfill)	4,600	2,800	329	9,880
Underground	2,210	1,100	129	3,880
In situ	1,510	720	88	2,650
Tract C-b				
Underground	2,210	1,100	139	4,180
In situ	1,630	650	82	2,470

The derivation of the "Total Acres Affected" and "Average Area Lost to Grazing" is explained in Volume I, Chapter III. The animal unit months of grazing loss figures are based upon an average carrying capacity of 8.5 acres/AUM for Tract C-a and 7.9 acres/AUM for Tract C-b. It is assumed that revegetation will commence as soon as development activities cease and forage production restored to the predevelopment level within three years.

Two livestock operators are presently licensed to graze cattle on Tract C-a. The livestock grazing losses indicated in the above table would result in reductions in their Federal range grazing licenses of 4% and 13% for an open pit operation; 2% and 5% reduction for underground; and 1% and 3% reduction for an in situ operation. Including private lands used by these operators, the maximum reduction would be less than 2% of the total livestock operations by the two operators.

Five livestock operators are licensed to graze cattle on Tract C-b. Proportional Federal range grazing license reductions in response to grazing loss from either underground or in situ development would be less than 1% for each of the livestock operators.

2. Utah Tracts

The impacts of development on grazing on Tracts U-a and U-b would be similar to those described for the Colorado Tracts, assuming an average carrying capacity of 7.0 acres/AUM.

The following table indicates the reduction in grazing use that would be expected from two typical development methods. (The figures are based upon a 50,000 bbl/day, 30-year operation involving both tracts):

Operation	Total Acres Affected	Average Area Lost to Grazing Acres/yr.	Average Grazing Loss AUMs'/yr	30-yr Accumulative Total AUM Loss
Underground	2,210	1,100	157	4,710
In situ	8,700	1,550	221	6,640

The livestock operators are licensed to graze sheep on Tract U-a and U-b. Proportional grazing license reductions corresponding to grazing loss on either tract from underground mining and surface retorting would amount to 1.9%, 1.5% and 1.1%.

The reductions corresponding to losses resulting from in situ development would be 2.7%, 2.2%, and 1.6%. None of these reductions would constitute over 1% of an operator's total operation, which include private lands.

3. Wyoming Tracts

The impacts of development on grazing on Tracts W-a and W-b would be similar to those previously described.

The following table indicates the reduction in grazing use that would be expected from a 50,000 bbl/day, 30-year in situ operation involving both tracts assuming an average carrying capacity of 7.6 acres/AUM.

Two livestock operators graze sheep on Tracts W-a and W-b. Proportional grazing license reductions corresponding to forage loss resulting from in situ development would be 3.1% and 1.6%

respectively. Such reductions would constitute less than 1% of either operator's total operation.

Operation	Total Area Affected	Average Lost to Grazing Acres/yr.	Average Grazing Loss AUMs'/yr	30-yr Accumulative Total AUM Loss
In situ	7,270	1,300	171	5,130

F. Impacts on Esthetics and Recreation

1. Colorado Tracts

Presently the area is remote and sparsely used by hunters and oil, gas, and ranching personnel. There is little incidence of air pollution, other than vehicular raised dust and smoke from occasional wildfires. Noise is intermittent, and its primary sources are related to aircraft passage and scattered drilling rigs exploring for oil, natural gas, or oil shale resources. The natural landscape of the area is in some places marred by roads and trails, cleared fence lines and gas pipelines on cleared rights-of-way.

Assuming surface-mine development, the tract would lose its natural quiet at the mine and plant site. Noises associated with the activities of the operation will be greatest at the mine, plant site, and in the Douglas Creek drainage adjacent to the active shale disposal site.

Air quality would be degraded by dust from waste or vehicles. Impact from the mine and retort may not be noticeable in the immediate area during the summer months since normal corrective lifting will put particles into prevailing winds aloft. However, inversions during the winter months may trap and concentrate emissions over the Piceance Basin and could result in further accumulation of particulate contaminants with lowered visibility.

The visual impact from the disposal of spent shale and overburden storage would be noticeable until restoration activities

are completed. The plant would be visible from ridge tops miles away. Spent shale disposal in the Douglas Creek drainage would alter the view of Cathedral Bluffs from the Douglas Creek drainage and from the top of the bluffs. However, the development of a large surface mine would provide an unusual attraction which could increase tourist traffic.

Some visual impact on the asymmetric landscape would result from utility rights-of-way such as pipelines, powerlines, roads, and stacks and plumes. During the first 5 years, surface mine development would eliminate approximately 50 percent of the existing recreation on Tract C-a and at the disposal site in the Douglas Creek area; 60 percent in 20 years; and 70 percent in 30 years. After vegetation has been successfully reestablished on the tract, the area would be able to sustain levels of recreation that may be similar to those previously existing.

With underground mining on Tract C-b, recreation opportunities lost would be small during the first 5 years; with 30 and 50 percent in 20 and 30 years, respectively, assuming no rehabilitation, and 15 and 20 percent with rehabilitation.

With in situ mining, the recreational lost would be approximately 20 percent after 10 years operation.

In addition, deer hunters will be displaced from the tract to other areas in the Piceance Creek Basin and/or adjacent regions. These hunters, as well as those related to normal population growth, will increase hunter density in the adjacent areas, thus lowering the existing quality of the hunting experience.

Outdoor recreational benefits which may be gained because of improved accessibility include sightseeing, both on and off the road camping, and fishing throughout the basin and on adjacent private and public lands (White River National Forest and BLM areas). In addition, the oil-shale project may increase visitor use of the basin as a tourist attraction beyond that of normal outdoor recreation activities.

2. Utah Tracts

Presently, the area is characterized by desert shrub and pinyon-juniper communities, and the terrain is sharpely cut by deep canyons with numerous buttes and spires. It is relatively remote and basically is a primitive area. Recreational visitor use is presently light with an estimated 50 visitor-days consisting mainly of hunting, rockhounding, and sightseeing.

Assuming development by underground mining, the area will be changed from its present state to a semi-industrial environment. It is estimated that less than 5 percent of the outdoor recreation resources would be lost during the first 3 years of operation, 15 percent at 10 years, 30 percent at 20 years, and 50 percent at 30 years. With successful rehabilitation, 16 and 20 percent of the tract site would be adversely affected at 20 and 30 years, respectively.

The required pipelines, powerlines, roads and other service facilities would change the existing landscape. Noise created by crushing, and retorting operation, and the movement

of heavy equipment in disposing of spent shales would impact the aesthetic value of the areas as would the minor petroleum odors from the retorted hydrocarbon liquids and gases.

It is likely that there will be an increase of outdoor recreational visitor use both on and around the project areas caused by normal population growth plus that caused by plant personnel and their families for sightseeing, picnicking, hunting, rockhounding, and floating and fishing on the White River.

With in situ mining, outdoor recreation loss would be small during the first 5 years of operation, since that recovery method could probably be initiated before that time. After 3 years of an in situ operation, approximately 350 acres per year of new land would be affected, however, with restoration this area should largely be returned for recreational use. The total area, considering restoration, that could be affected during the life of the project could approach 1,800 acres.

3. Wyoming Tracts

Presently, the area is remote, semi-primitive and sparsely settled, However, several hundred man-days are expended annually within the tract boundaries in recreational uses.

With the proposed project, the area will be changed from its present state to a semi-industrial environment requiring approximately 40-50 surface acres for an in situ processing system, and approximately 1,600 surface acres per year for development.

The activity would change the existing landscape because of the need for pipelines, powerlines, roads and other service facilities. It would also create noise caused by crushing and retorting operations of heavy equipment as well as minor petroleum odors from the retorted hydrocarbon liquids and gases.

The installation and associated activity would impair the scenic wide open space views from Kinney Rim. It is likely that there will be an increased recreation use caused by normal population growth plus that caused by plant personnel and their families for sightseeing.

G. Impacts on Existing Economic and Social Development

This section summarizes the local regional economic and social impacts associated with the development of six prototype leases. For a more thorough discussion of the regional impact of increased population due to oil shale development (see Volume 1, Chapter III).

1. Colorado Tracts

Rangely, Rio Blanco County, might be expected to be the residence of most of the population generated by development at Tract C-a in Rio Blanco County. Rangely is also accessible from the Utah tract and one-third of the population generated by that tract is projected to reside in Rangely. Thus the population of Rangely could increase from 1,500 to 10,500. If the C-a Tract proves to be inaccessible from existing communities in the winter because of snow conditions, an entirely new community could develop

close to the tract to house up to 10,500 people associated with this tract.

Meeker in Rio Blanco County might be expected to be the residence of almost all the population associated with the C-b Tract in Rio Blanco County. The population of Meeker could increase from 1,500 to 9,850.

Rifle, Glenwood Springs, and a number of smaller communities in Garfield County would be expected to receive more than one-half of the 25,100 population increase associated with plants on non-Federal lands. Rifle could increase from 2,500 to 10,000, Glenwood Springs from 4,100 to 9,500, and Grand Valley and DeBeque could have a combined increase of 2,700.

Grand Junction, in Mesa County, would receive the remaining population associated with the non-Federal plants. In addition, part of the population associated with the C-a Tract could reside in Grand Junction. The population of Grand Junction could increase from 20,170 to 33,000. The expansion of public facilities in Grand Junction necessitated by this population increase may be difficult to finance since the oil shale plants with this new population will be in Garfield County. The property taxes on these plants will therefore be collected by Garfield County.

The three Colorado counties have formed an Oil Shale Regional Planning Commission to study the regional impact of an oil shale industry and to advise the individual counties of their findings. Each of these counties has their own planning commission. Rio

Blanco and Mesa Counties have adopted zoning ordinances for subdivisions and mobile home parks.

These regulations include such provisions as a minimum lot size of 5 acres for lots not served by public sewer and the requirement that each space in a mobile home park be served by running water and a public sewer.

Zoning and planning can control the quality of new urban developments. However, when a town grows to as much as six times its original size in a short period, there will very likely be disruptions to the routine of both the old and new populations during construction. These disruptions would be caused by the physical activity of construction and by the short-term shortages of utilities, housing, or services that may be caused by poor planning. Such large scale growth can result in a town having an entirely different ethnic, cultural, and religious composition after expansion than it had before.

Non-agricultural employment in the three counties was about evenly divided between white collar and blue collar jobs in 1970. Most of the new oil shale plant jobs will be blue collar, but the urban support jobs associated with these will be both white collar and service. The overall composition of employment therefore will shift toward a larger percentage of blue collar jobs.

These shifts in the composition of urban population could cause strains to develop between the established residents and the newcomers. For example, workers on different time shifts

will also have different sleeping and recreation patterns. A mutual effort will be needed to mitigate these strains as they appear.

a. Local Government

Revenues to county governments in Colorado have ranged from $133 per capita in Mesa County and $157 per capita in Garfield County where there is little industry, to $325 per capita in Rio Blanco County where petroleum producing properties contribute to the county tax revenue.

The tax revenue to local governments that will be generated by an oil shale plant, and the taxable property belonging to the associated new population is estimated to be approximately $1,000 per new resident. The net effect of oil shale development therefore will be to raise the per capita tax revenue to the county in which the plant is located. This will make it easier for the affected county to provide the necessary services for both the additional residents and the public facilities used for access to the oil shale plant. Increased population and development will also raise the local demand for public road, utility, police, fire protection and other government services. Couties whose population is increased due to an oil shale plant located in an adjacent county may suffer a decline in per capita tax revenue unless tax rates are increased.

In Colorado, the two Federal tracts are in Rio Blanco County and nearly all of the population associated with these plants would be expected to reside in that county. In addition, Rio Blanco County may be the residence of some of the employees of the oil shale plant on the Federal tract in Utah. Rio Blanco

County would not get the benefit of any of the local taxes paid by that plant. The net taxes of Rio Blanco County per new resident could therefore be less than $1,000 per person.

Several oil shale plants could be built on private lands in Garfield County. If part of the population associated with these plants resided in Mesa County, Garfield County would receive more than $1,000 in tax revenues per new resident. Mesa County on the other hand, with added population but no oil shale plant would receive only those tax revenues generated by the property of the new residents and associated businesses located in Mesa County.

b. Commuting Patterns

As a result of studies conducted by the Rio Blanco Planning Commission, a county road traversing the Piceance Creek Basin has recently been paved to State Highway 64 between Rangely and Meeker and comes within 16 miles of Tract C-a and within one mile of Tract C-b. The tracts are approximately 40 miles from either Rangely or Meeker via this route.

c. Impact on Indians

There is no sizable community of Indians existing in the oil shale area.

2. Utah Tracts

The 50,000-barrel-per-day oil shale capacity in Uintah County would generate a population increase of about 8,400. The plant site is accessible from both Vernal, Utah, and Rangely,

Colorado. Two-thirds of the associated population would be expected to reside in Vernal, and the population of Vernal could increase from 4,000 to 9,500.

The Planning Commission of Vernal, Utah, has developed a planning and zoning program for the whole of Uintah County. It has already been implemented for the city of Vernal but not for the whole county.

Employment in the city of Vernal is approximately 60 percent white collar. The influx of oil shale operating personnel and the accompanying urban support personnel will tend to shift this distribution toward a high percentage of blue collar workers.

The same sort of social strains can be expected to develop in Vernal as were discussed in the previous section on Colorado tracts.

a. Local Government

The Uintah County tax revenue in 1962 was $112 per person. An oil shale plant and related residences and business is expected to generate approximately $1,000 in local tax revenues per new resident. If some portion of the population associated with the Uintah County Federal oil shale lease and plant reside in Colorado, the tax revenue to Uintah County will exceed $1,000 for each new resident. Demand for services would also increase.

b. Commuting Patterns

The two communities of substantial size nearest the Utah tracts are Vernal, Utah, and Rangely, Colorado. Vernal is located

approximately 60 miles northwest of the tract sites. The tracts can be reached by going east from Vernal on Federal Highway 40 for 30 miles, south on State Highway 45 for approximately 20 miles and continuing south on a county dirt road for the last 10 miles.

Rangely, Colorado, is also approximately 60 miles from the Utah tracts and is expected to be the residence of some of the workers from these sites. Traveling from Rangely will entail driving west on Colorado State Highway 64 for 30 miles, six miles on Federal Highway 40 and south on Utah State Highway 45 for 20 miles, the same route as the Vernal commuters to the county road for the last 10 miles.

c. Impact on Indians

The Uinta Basin, in which Tracts U-a and U-b are located, also includes a portion of the Uintah and Ouray Indian Reservation. The reservation lands lie to the west and north of the tracts and therefore, it is expected that neither commuting patterns nor residential developments will affect tribal lands. Vernal, the community which will be the residence of most of the workers for the Utah tracts, is also east of the reservation.

The Uintah and Ouray Indian tribes will be affected by the oil shale development through the probably increased usage of their recreational and tourist facilities. These tribes have established these facilities as one of their major sources of income. Almost the entire southern half of the reservation is

utilized for recreational facilities, primarily hunting and fishing and the tribes have established a motel complex in the north close to Vernal. The increased population in the area will probably rely to a large extent on the tribal developed recreational facilities and thereby contribute to their income.

An additional impact on the Uintah and Ouray tribes caused by the prototype leasing program may be the creation of employment opportunities. Many of these Indians have had prior experience working in mines. At the present time the tribes' main source of income is their recreational and tourist facilities. This program may have a favorable impact upon the Uintah and Ouray tribal economics.

3. Wyoming Tracts

The 50,000-barrel-per-day capacity in Sweetwater County, Wyoming, would generate an associated population increase of about 6,900. These people most likely would reside in Rock Springs and Green River. The population of Rock Springs could increase from 11,650 to 17,000 and that of Green River from 4,200 to just over 6,000.

The Sweetwater County Planning Commission has adopted zoning regulations comparable to those of Rio Blanco County, Colorado.

Both Rock Springs and Sweetwater County already have more blue collar employment than white collar employment. The development of an oil shale plant will enlarge the proportion of blue collar employees.

The social strains that may develop in Sweetwater County would be the same as described for Colorado, but may be less severe because the towns of Rock Springs and Green River are expected to expand by only 50 percent and already have predominantly blue collar employment.

a. Local Government

The local tax revenue in Sweetwater County in 1962 was $113 per capita. The local taxes to be generated by the oil shale plant and associated residences and businesses are expected to approximate $1,000 per new resident. The average per capita tax revenue to Sweetwater County would therefore be increased by the addition of a shale oil plant. Demand for services would also be increased.

b. Commuting Patterns

The Washakie Basin tracts are located 50 to 60 miles southeast of Rock Springs and Green River, both of which are located on Interstate 80. Green River is approximately 10 miles west of Rock Springs. From Rock Springs, the workers would drive about 40 miles south on State Highway 430 which passes 10 miles to the west of the tracts. There is no marked road between the tracts and State Highway 430.

c. Impact on Indians

There is no sizable community of Indians existing in the oil shale area.

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7. McKean, W.C., and R.M. Bartmann 1971: Deer-livestock relations on a pinyon-juniper range in northwestern Colorado; Colorado Division of Game, Fish, and Parks, final report, Federal Aid Project W-101-R.

V. MITIGATING MEASURES INCLUDED IN THE PROPOSED ACTION

A. Oil Shale Lease

The mitigating measures which would be taken to assure that the environmental concepts presented in this Environmental Statement would be satisfied are contained in the proposed lease which includes environmental stipulations (Section A) and Off-Tract Stipulations (Section B) that supplement the Department's regulations governing surface exploration, mining and reclamation of lands (43 CFR Part 23) (Section C) and the operating regulations for mining (30 CFR 231) (Section D). The requirements under the lease and regulations would require compliance with all applicable State and Federal regulations. The lease would further provide that future standards which may be promulgated would have to be met unless inconsistent with specific provisions of the lease. Special stipulations developed for this proposed prototype program would place additional requirements on the lessee to insure that the environmental impact caused by prototype oil shale development on the immediate and adjacent area would be minimized.

A revision of Section 3000.0-5 of Subpart 3000, Chapter II, Title 43 of the Code of Federal Regulations appearing in the Federal Register, July 23, 1973, Volume 38 - Number 140 pertaining to appeals is presented in Section E of this Chapter.

The provisions (1) for offsetting extraordinary environmental costs against royalties, (2) for offsetting certain expenditures against the 4th and 5th bonus installments, and against royalties between the 6th and 10th anniversary dates, and (3) for the relief

from a portion of any production royalties prior to the 8th anniversary date are designed to achieve an environmental and industrial balance. These provisions were devised only for the six prototype leases to promote the development of a presently nonexisting industry. There are no plans to include similar provisions in any subsequent leases.

UNITED STATES DEPARTMENT OF INTERIOR

BUREAU OF LAND MANAGEMENT

OIL SHALE LEASE

OIL SHALE LEASE ENVIRONMENTAL STIPULATIONS

(A) Mine Waste

(B) Other Disposal Areas

(C) Disposal of Solid and Liquid Wastes

(D) Impoundment of Water

(E) Slurry Waste Disposal

UNITED STATES DEPARTMENT OF THE INTERIOR

BUREAU OF LAND MANAGEMENT

OIL SHALE LEASE

In consideration of the mutual promises, terms and conditions contained herein, and the grant made hereby, this lease is entered into on _______________, ______, to be effective on _________________, ______, (hereinafter called the "Effective Date"), by the United States of America (hereinafter called the "Lessor"), acting through the Bureau of Land Management (hereinafter called the "Bureau") of the Department of the Interior (hereinafter called the "Department"), and ____________________

____

(hereinafter called the "Lessee"), pursuant and subject to the terms and provisions of the Mineral Leasing Act of February 25, 1920 (41 Stat. 437), as amended (30 U.S.C. §§181-263) (hereinafter called the "Act"), and to the terms, conditions, and requirements (1) of all regulations promulgated by the Secretary of the Interior (hereinafter called the "Secretary") in existence upon the Effective Date, specifically including, but not limited to, the regulations in 30 CFR Part 231 and 43 CFR Part 23 and Group 3000, all of which are incorporated herein and, by reference, made a part hereof; and (2) of all regulations hereafter promulgated by the Secretary (except those inconsistent with any specific provisions of this lease other than regulations incorporated herein

by reference), all of which shall be, upon their effective date, incorporated in and, by reference, made a part of this lease.

Section 1. <u>Definitions</u>

As used in this lease:

(a) "Oil Shale" means a fine-grained sedimentary rock containing: (1) organic matter which was derived chiefly from aquatic organisms or waxy spores or pollen grains, which is only slightly soluble in ordinary petroleum solvents, and of which a large proportion is distillable into synthetic petroleum, and (2) inorganic matter which may contain other minerals. This term is applicable to any argillaceous, carbonate, or siliceous sedimentary rock which, through destructive distillation, will yield synthetic petroleum. The products of Oil Shale include both shale oil and other minerals;

(b) "Leased Lands" means ____________________ situated in the County of ____________, State of __________, containing ________ acres, more or less;

(c) "Leased Deposits" means all despoits of Oil Shale lying within or under the Leased Lands;

(d) "Anniversary Date" means the anniversary of the Effective Date of this lease; however, if operations under this lease are suspended pursuant to section 39 of the Act (30 U.S.C. §209), the next Anniversary Date of this lease after the suspension shall follow the previous Anniversary Date by a period of time equal to the sum of one year and the period of suspension, and subsequent

Anniversary Dates will be measured from that Anniversary Date;

(e) "Lease Year" means the period of time between two successive Anniversary Dates of this lease;

(f) "Ton" means a measure of weight of 2,000 pounds avoirdupois; and

(g) "Mining Supervisor" means the appropriate mining supervisor of the United States Geological Survey (hereinafter called the "Geological Survey"), as defined in 30 CFR 231.2(c).

Section 2. Grant to Lessee

The Lessee is hereby granted, subject to the terms and conditions of this lease, the exclusive right and privilege to prospect for, mine, process by retorting or by in situ methods or otherwise, utilize, and dispose of all Leased Deposits together with the right to construct on the Leased Lands all such works, buildings, plants, structures, roads, powerlines, and additional facilities as may be necessary or reasonably convenient for the mining, processing, and preparation of products of the Leased Deposits for market and the housing and welfare of the Lessee's employees, agents, and contractors, and to use so much of the surface of the Leased Lands as may reasonably be required in the exercise of the rights and privileges herein granted.

Section 3. Lessor's reserved interests in the Leased Lands

The Lessor reserves the following:

(a) The right to lease, sell, or otherwise dispose of the surface of the Leased Lands or of any surface or mineral resource in the Leased Lands (or of any interest therein) under existing laws or laws hereafter enacted, subject to the rights of the Lessee under this lease;

(b) The right, upon such terms as it may determine to be just, to permit for joint or several use, such easements or rights-of-way, including easements in tunnels upon, through, or in the Leased Lands, as may be necessary or appropriate to the working of the Leased Lands or other lands containing mineral deposits subject to the Act, and the treatment and shipment of the products thereof by or under authority of the Lessor, its Lessees, or permittees, and for other public purposes; and

(c) The right to conduct and to authorize geological and other investigations on the Leased Lands which do not interfere with or endanger operations under this lease.

Section 4. Lease Term

This lease shall be for a period of 20 Lease Years from the Effective Date and so long thereafter as there is production from the Leased Deposits in commercial quantities, subject to the provisions of section 23 with respect to the readjustment of terms and conditions and the right of the parties to terminate

the lease.

Section 5. <u>Bonus</u>

In addition to all other payments required hereunder, the Lessee shall pay to the Lessor the amount of $_______ as a bonus. This bonus shall be due and payable in five installments as follows: Receipt of $_____ at the time of the sale as the first installment is hereby acknowledged by the Lessor; the balance shall be paid in four equal annual installments of $______ due and payable on each of the first four Anniversary Dates of this lease. In the event the Secretary accepts a surrender or relinquishment of this lease filed by the Lessee at any time prior to the third Anniversary Date, the Lessee shall be released from any obligation to pay the fourth and fifth bonus installments required hereunder. That release shall not relieve the Lessee of the obligation to pay installments which had accrued prior to the filing of the surrender or relinquishment of the lease, but had not been paid prior to the Secretary's acceptance of that surrender or relinquishment. The Lessee may credit against the fourth bonus installment any expenditures prior to the third Anniversary Date directly attributable to operations under this lease on the Leased Lands for the development of the Leased Deposits, but not any expenditures

attributable to the preparation of a development plan under section 10 of this lease. Upon the credit of an expenditure, the Lessee shall be relieved of the duty of paying the equivalent amount of the fourth bonus installment. Similarly, the Lessee may credit against the fifth bonus installment any expenditures prior to the fourth Anniversary Date directly attributable to operations under this lease on the Leased Lands for the development of the Leased Deposits and not credited against the fourth bonus installment, but not any expenditures attributable to the preparation of a development plan under section 10. Upon the credit of an expenditure, the Lessee shall be relieved of the duty of paying the equivalent amount of the fifth bonus installment. The Mining Supervisor shall have the duty of determining whether expenditures credited by the Lessee are properly attributable to such operations, and, if the Mining Supervisor determines that any reported expenditure is not attributable to such operations, the Lessee shall not receive credit for that expenditure.

Section 6. Rentals

The Lessee shall pay the Lessor an annual rental which shall be in the amount of 50 cents for each acre or fraction of an acre of the Leased Lands. Receipt of rental for the first Lease Year is hereby acknowledged. The Lessee shall pay the rental for each subsequent Lease Year on or before the first day of that Lease Year. Rentals

for any Lease Year shall be credited by the Lessor against any royalty payments for that Lease Year.

Section 7. Royalties

(a) The lessee shall pay to the Lessor a royalty on all Oil Shale extracted by the Lessee from the Leased Lands which is either processed or sold by the Lessee. The royalty on Oil Shale shall be computed separately for shale oil and for other minerals as follows:

(1) The royalty on shale oil shall be computed on the basis of the shale oil content of the Oil Shale; the method of computing the royalty shall depend upon whether the Oil Shale is extracted by mining methods or processed by in situ methods.

(i) If the Oil Shale is extracted by mining methods, the Lessee shall pay the Lessor a basic royalty rate of 12 cents on every Ton of Oil Shale which the Lessee either processes under this Lease either on or off the Leased Lands or sells prior to processing. This basic royalty rate shall be subject to the following adjustments:

(A) If the shale oil content of the Oil Shale mined is less than 30 gallons per Ton, the basic royalty rate per Ton of Oil Shale shall be reduced by one cent for each gallon or fraction thereof that the shale oil content is less than 30 gallons per Ton, but in no event shall the royalty rate be less than four cents per Ton. If the shale oil content of the Oil Shale

mined is more than 30 gallons per Ton, the basic royalty rate per Ton shall be increased by one cent for each gallon or fraction thereof that the shale oil content is more than 30 gallons per Ton.

(B) For the calendar year in which the Effective Date occurs and for each calendar year thereafter, the Secretary shall determine the combined average value per barrel of all crude oil and crude shale oil produced in the States of Colorado, Utah, and Wyoming. The basic royalty rate applicable to the second and each succeeding Lease Year shall be adjusted by an increase or decrease of the same percentage as the percentage of increase or decrease in the combined average value for the calendar year during which that Lease Year begins as compared with the combined average value for the calendar year during which the previous Lease Year began. However, in no event shall the basic royalty rate for shale oil be decreased to less than 4 cents on every Ton of Oil Shale mined under the lease.

(C) The shale oil content of the Oil Shale shall be determined either by the Modified Fischer Assay method or by such other method as the Lessor and the Lessee adopt, and the royalty shall be based on the monthly average of shale oil content of all Oil Shale processed under this lease or transferred from the Leased Lands for processing or sale by the Lessee. Computations of quantities, assays and royalties shall be rounded to the nearest hundredth.

(ii) (A) If the Oil Shale is processed by in situ methods, royalty shall be paid at a basic royalty rate of 12 cents per Ton. The number of Tons processed shall, for purposes of computing royalty, be determined by: (I) establishing through calorimetric tests designated by the American Society for Testing and Materials as "Standard" or "Tentative, the total gross heat of combustion in BTUs of all oil and gas products at the well head, adjusted downward by the total gross heat of combustion in BTUs of combustible fluids (gases or liquids) injected as heat carriers, but not for fuel purposes, into the formation being processed; (II) dividing the adjusted total gross heat of combustion in BTUs by 152,700 BTUs (shale oil and gas recovered by Modified Fischer Assay of Oil Shales, containing approximately 30 gallons of shale oil per Ton, has a heating value of 152,700 BTUs per gallon of shale oil and associated gas), to arrive at the equivalent number of gallons of shale oil produced; and (III) dividing the equivalent number of gallons of shale oil produced by 30, to arrive at the number of Tons of Oil Shale processed by in situ methods.

(B) The basic royalty rate applicable to shale oil from Oil Shale processed by in situ methods shall be adjusted in the same manner as that provided in paragraph (a)(1)(i)(B) of this section for the adjustment of the basic royalty rate applicable to shale oil processed from Oil Shale extracted by mining methods.

(C) Computations of quantities, assays and royalties relating to tonnage of Oil Shale shall be rounded to the nearest hundredth.

(2) The Lessee shall also pay a royalty on all minerals other than shale oil contained in Oil Shale produced from the Leased Deposits which the Lessee processes, either on or off the Leased Lands, or sells. This royalty shall be computed on the basis of the gross value of the other minerals at the point of shipment to market, and shall be at a rate of 3 per centum for the first ten Lease Years, 4 per centum for the eleventh year through the fifteenth Lease Year, and 5 per centum beginning with the sixteenth Lease Year.

(b) The Lessee shall determine accurately, on the Leased Lands, the weight or quantity and quality of all Oil Shale produced from the Leased Deposits by each method used and shall enter the weight or quantity and quality thereof accurately in books which shall be kept and preserved by the Lessee for such purposes.

(c) Payments for royalties due under this lease shall be payable monthly on or before the last day of the calendar month following the calendar month in which the Oil Shale is processed or, if it is not processed, is sold.

(d) If the Lessee shall show that compliance with the requirements for environmental protection prescribed in the detailed development plan (or amended, supplemental, or partial plan)

required under section 10 of this lease, and as approved in accordance with the regulations in 43 CFR Part 23 and 30 CFR Part 231, now or hereinafter in force, or imposed by legislation enacted after the effective date of that plan (or of an amendment or supplement to that plan), has engendered or will engender extraordinary costs in an amount which is in excess of those in the contemplation of the parties, as determined by the Lessor, on the effective date of that plan (or amendment or supplement to that plan), and the Secretary, if he deems it desirable, may, in order to offset such costs, adjust the royalties that would otherwise become due and payable thereafter under subsection (a) of this section by allowing a credit against those royalties in such an amount, and for such a time, as he determines is warranted in the circumstances.

(e) (1) For the sixth and each succeeding Lease Year the Lessee shall pay a minimum royalty which, to the extent that royalties on production during that Lease Year in that amount have not been previously paid, shall be due and payable on the Anniversary Date at the end of that Lease Year. For the sixth Lease Year, the Lessee's minimum royalty shall be equal to the royalty due on shale oil under subsection (a)(1)(i) of this section on

an annual production rate of ____________ Tons of Oil Shale containing 30 gallons of shale oil per Ton of Oil Shale. The annual production rate for computing minimum royalty for each subsequent Lease Year up to and including the fifteenth Lease Year shall increase in an amount of ________ Tons of Oil Shale per year for each subsequent Lease Year; for the fifteenth and each subsequent Lease Year the annual rate shall be __________ Tons of Oil Shale. The Secretary may excuse the Lessee from compliance, in whole or in part, with the requirements of this paragraph (1) of subsection (e) during any year in which the Lessee is prevented by circumstances over which he has no control from implementing a development plan submitted under Section 10 of this lease.

(2) The Lessee may credit against any minimum royalty due on the sixth Anniversary Date or any subsequent Anniversary Date up to and including the tenth Anniversary Date the amount of any expenditures which are made between the approval of the development plan under Section 10 of this lease and the tenth Anniversary Date and which are directly attributable to operations on the Leased Lands pursuant to that development plan for the development of the Leased Deposits and which were not credited against the fourth and fifth bonus installments. The Mining Supervisor shall have the duty of determining whether expenditures credited by the Lessee are attributable to such operations, and, if the Mining Supervisor determines that any reported expenditures is not attributable to such operations, the Lessee shall not receive credit for the expenditure. Upon the credit of an expenditure against the minimum royalty due, the Lessee will be relieved of the duty of paying the equivalent amount of minimum royalty: Provided, however, that, if there is actual production in the sixth or any subsequent Lease Year, the Lessee shall not be

permitted to credit expenditures against the first $10,000 of minimum royalty due for that Lease Year.

(f) If the Lessee enters into production prior to the eighth Anniversary Date, and the royalty due in the eighth or any previous Lease Year exceeds the minimum royalty due under subsection (e)(1) of this section for that Lease Year, the Lessee shall be relieved from the payment of one-half of the difference between the actual royalty due for that Lease Year and the figure set in subsection (e)(1) for minimum royalty due for that Lease Year. This relief from the payment of royalty shall be in addition to any crediting of expenditures under subsection (e)(2) of this section, but no crediting of expenditures against minimum royalty shall reduce the figure for minimum royalty used in the preceding sentence.

Section 8. Payments

All bonus installments shall be paid to the appropriate State Office of the Bureau. All rental payments shall be made to the appropriate State Office of the Bureau until this lease enters a producing status or minimum royalty is required to be paid on it; thereafter the rentals and royalties shall be paid to the appropriate Mining Supervisor with whom all reports (including any reports on expenditures deductible under section 5) concerning operations under the lease shall be filed. All

remittances to the Bureau shall be made payable to the Bureau of Land Management; those to the Geological Survey shall be made payable to the United States Geological Survey.

Section 9. Bond

(a) The Lessee shall maintain a bond in the amount of $20,000 for the purpose of ensuring compliance with the provisions of this lease, except those provisions for compliance with which a separate bond is required under subsection (b) of this section.

(b) (1) Upon approval of a detailed development plan under section 10 of this lease, the Lessee shall file with the Lessor and maintain, in addition to the bond required under subsection (a) of this section, a bond (in an amount determined pursuant to paragraph (2) of this subsection) which shall be conditioned upon the faithful compliance with the regulations in 30 CFR Part 231 and 43 CFR Part 23, the provisions of sections 10 and 11 of this lease, the Oil Shale Lease Environmental Stipulations attached to this lease pursuant to section 11, and any approved development plan (or approved, amended, supplemental or partial plan), to the extent that it relates to the preservation and protection of the environment (including land, water, and air), the protection and conservation of resources other than Oil Shale during the conduct of exploration or mining operations, and the reclamation of lands and waters affected by exploration or mining operations.

(2) During the first three Lease Years after the approval of a detailed development plan under section 10 of this lease, the bond shall be in an amount equal to (i) $2,000 per acre for all portions of the Leased Lands and other lands which, pursuant to the plan, will be used for spent shale disposal sites and sites for actual mining operations during that three year period and (ii) $500 per acre for all other portions of the Leased Lands and other lands upon which operations will be conducted or which will be directly affected by operations during that three year period under the plan, but the total bond shall in no event be less than $20,000. After the first three Lease Years the bond shall be renewed at intervals of three Lease Years. Each renewed bond shall be for three Lease Years and at such a total figure as shall be determined by the Lessor to be needed to provide for the reclamation and restoration of all portions of the Leased Lands which have been affected by previous operations under this lease or which will be affected by operations under this lease during the ensuing three year period. The amount of the bond shall be increased at any time during the three-year period at the demand of the Lessor if there is a change in the development plan which, in the opinion of the Lessor, increases the possibility of environmental damage. Upon request of the Lessee, the bond may be released as to all or any portion of the Leased Lands affected by exploration or mining operations during the three year period covered by the bond when the Lessor has determined that the Lessee has successfully met the reclamation requirements of the approved development plan and that operations have been carried out and completed with respect to these lands in accordance with the approved plan.

(c) Prior to the approval of any plan for exploratory work under section 10(d) of this lease, the Lessee shall file with the Lessor and maintain, in addition to the bond required under subsection (a) of this section, a bond in such an amount as the Mining Supervisor shall require, but in no event less than $20,000, which shall be conditioned upon the faithful compliance with the regulations in 30 CFR Part 231 and 43 CFR Part 23, the provisions of sections 10 and 11 of this lease, the Oil Shale Lease Environmental Stipulations attached to this lease pursuant to section 11, and any approved plan for exploratory work, to the extent that it relates to the preservation and protection of the environment (including land, water, and air), the protection and conservation of resources other than Oil Shale during the conduct of exploration operations, and the reclamation of lands and waters affected by exploration operations. The bond required by this subsection shall apply only to actions taken prior to the date of approval of the development plan under section 10(a) of this lease. However, with the consent of the Mining Supervisor, the Lessee may modify this bond in such a manner as is necessary to meet the requirements of subsection (b) of this section, and the bond so modified may, with the consent of the Mining Supervisor, be maintained as the bond required under subsection (b).

Section 10. Development plan and diligence requirements

(a) The Lessee shall file with the Mining Supervisor on or

before the third Anniversary Date a detailed development plan. This plan shall include: (1) a schedule of the planning, exploratory, development, production, processing, and reclamation operations and all other activities to be conducted under this lease; (2) a detailed description pursuant to 30 CFR Part 231 and 43 CFR Part 23 of the procedures to be followed to assure that the development plan, and lease operations thereunder, will meet and conform to the environmental criteria and controls incorporated in the lease; and (3) a requirement that the Lessee use all due diligence in the orderly development of the Leased Deposits, and, in particular, to attain, at as early a time as is consistent with compliance with all the provisions of this lease, production at a rate at least equal to the rate on which minimum royalty is computed under section 7(e)(1). Prior to commencing any of the operations under the development plan in the Leased Lands, the Lessee shall obtain the Mining Supervisor's approval of the development plan. The Mining Supervisor shall not delay unnecessarily in the consideration of a development plan, but he shall take time to consider both technical and environmental provisions of the plan thoroughly prior to approval, and may hold public hearings on the environmental provisions to assist him in his consideration of the plan. If the development plan submitted by the Lessee is unacceptable, the Mining Supervisor shall inform the Lessee by written notice of the reasons why the development plan is

unacceptable and shall give him an opportunity to amend the plan. If an acceptable development plan is not submitted to the Mining Supervisor by the Lessee within one year after the Lessee's receipt of that notice, the Mining Supervisor shall send a second written notice to the Lessee concerning the unacceptability of the development plan. A failure by the Lessee to submit an acceptable plan within one year after his receipt of the second written notice, without reasonable justification for delay, shall be grounds for termination of the lease, if the Lessor so elects. Upon approval of the plan, the Lessee shall proceed to develop the Leased Deposits in accordance with the approved plan. After the date of approval of the development plan, the Lessee shall conduct no activities upon the Leased Lands except pursuant to that development plan, or except for necessary activities following a relinquishment under section 28 of this lease or for the disposition of property after termination pursuant to section 32 of this lease.

(b) The Lessee must obtain the written approval of the Mining Supervisor of any change in the plan approved under subsection (a).

(c) The Lessee shall file with the Mining Supervisor annual progress reports describing the operations conducted under the development plan required under subsection (a).

(d) Prior to undertaking any exploratory work on the Leased Lands between the Effective Date and the date of approval of the detailed development plan required by subsection (a) of this section, the Lessee shall file with the Mining Supervisor a plan

showing the exploratory work which he proposes to undertake and he shall not commence that exploratory work until the Mining Supervisor has approved the plan. Exploratory work, as used in this subsection, shall include, but not be limited to, seismic work, drilling, blasting, research operations, cross-country travel, the construction of roads and trails and other necessary facilities, and the accumulation of baseline data required under section 1(C) of the Oil Shale Lease Environmental Stipulations. Prior to approval of the detailed development plan under subsction (a) of this section, all exploratory work on the Leased Lands shall be conducted pursuant to a plan approved under this subsection.

Section 11. Protection of the environment; additional stipulations

(a) The Lessee shall conduct all operations under this lease in compliance with all applicable Federal, State and local water pollution control, water quality, air pollution control, and air quality laws, regulations, and standards.

(b) The Lessee shall avoid, or, where avoidance is impracticable, minimize and, where practicable, repair damage to the environment, including the land, the water and the air.

(c) The Oil Shale Lease Environmental Stipulations are attached to and specifically incorporated in this lease. A breach of any term of these stipulations will be a breach of the terms of this lease and subject to all the provisions of this lease with respect to remedies in case of default.

Section 12. Operations on the Leased Lands

(a) The Lessee shall exercise reasonable diligence, skill, and care in all operations on the Leased Lands. The Lessee's obligations shall include, but not be limited to, the following:

(1) The Lessee shall conduct all operations on the Leased Lands so as to prevent injury to life, health, or property.

(2) The Lessee shall avoid, or, where avoidance is impracticable, minimize and, where practicable, correct hazards to the public health and safety related to his operations on the Leased Lands.

(3) The Lessee shall avoid wasting the mineral deposits, and other resources, including but not limited to, surface resources, which may be found in, upon, or under such lands.

(b) The Lessee shall conduct all operations on the Leased Lands whether they are surface or underground mining operations, and whether they are in lands in which the Lessor owns the surface or those in which the Lessor has disposed of the surface, in accordance with the provisions of 30 CFR Part 231 and 43 CFR Part 23. Both 30 CFR Part 231 and 43 CFR Part 23 are specifically incorporated by reference into the provisions of this section. The provisions of 43 CFR Part 23 are hereby expressly made applicable to the Lessee's underground mining operations with equal force and effect to that given to those provisions in their application to surface

mining operations and to operations on lands in which the Lessor owns the surface.

(c) The Lessee shall take such reasonable steps, and shall conduct operations in such a manner, as he may be needed to avoid or, where avoidance is impracticable, to minimize and, where practicable, repair damage to: (1) any forage and timber growth on Federal or non-Federal lands in the vicinity of the Leased Lands; (2) crops, including forage, timber, or improvements of a surface owner; or (3) improvements, whether owned by the United States or by its permittees, licensees, or lessees. The Lessor must approve the steps to be taken and the restoration to be made in the event of the occurrence of damage described in this subsection.

Section 13. Development by in situ methods

Where in situ methods are used for development of Oil Shale, the Lessee shall not place any entry, well, or opening for such operations within 500 feet of the boundary line of the Leased Lands without the permission of, or unless directed by, the Mining Supervisor, nor shall induced fracturing extend to less than 100 feet from that boundary line.

Section 14. Nuclear fracturing

No nuclear explosive may be detonated on or in the Leased Lands without the express written approval of the Secretary. The Secretary may approve the detonations of such explosives only after the preparation of an environmental impact statement pursuant to section 102(2)(C) of the National Environmental Policy Act of 1969 (42 U.S.C. § 4332(2)(C)).

Section 15. Inspection and investigation

The Lessee shall permit any duly authorized officer or representative of the Department at any reasonable time:

(a) to inspect or investigate the Leased Lands and all surface and underground improvements, works, machinery, and equipment, and all books and records pertaining to operations and surveys or investigations under this lease; and

(b) to copy and make extracts from any books and records pertaining to operations under this lease.

Section 16. Reports, maps, etc.

(a) At such times and in such a form as the Lessor may prescribe, the Lessee shall furnish a report with respect to investment and operating costs under this lease. The Lessee shall also submit to the Lessor in such form as the latter may prescribe, not more than 60 days after the end of each quarter of the Lease Year, a report covering that quarter which shall show the amount of each respective mineral or product produced from the Leased Deposits by each method of production used during the quarter, the character and quality thereof, the amount of products and by-products disposed of and price received therefor, and the amount in storage or held for sale. This report shall be certified by the superintendent of the mine, or by some other agency having personal knowledge of the facts who has been designated by the Lessee for that purpose.

(b) The Lessee shall prepare and furnish at such times and in such form as the Lessor may prescribe, maps, photographs, reports, statements and other documents required by the provisions of 30 CFR Part 231 and 43 CFR Part 23.

Section 17. Notice

Any notice which is required under this lease shall be given in writing. Where immediate action is required, notice may be given orally or by telegram, but, where this is done, the oral notice shall be confirmed in writing. Wherever this lease requires the Lessee to give notice, notice shall be given to the Mining Supervisor unless this lease requires that notice be given to another officer. The Lessee shall inform the Bureau State Office and the Mining Supervisor of the Lessee's officer to whom notice shall be given.

Section 18. Employment practices

The Lessee shall pay all wages due persons employed on the Leased Lands at least twice each month in lawful money of the United States. The Lessee shall grant all miners and other employees complete freedom of purchase. The Lessee shall restrict the workday to not more than 8 hours in any one day for underground workers, except in cases of emergency. The Lessee shall employ no person under the age of 16 years in any mine below the surface. If the laws of the State in which the mine is situation prohibit the employment, in

a mine below the surface, of persons of an age greater than 16 years, the Lessee shall comply with those laws.

Section 19. Equal Opportunity Clause; certification of non-segregated facilities

(a) Equal Opportunity Clause. During the performance of this lease the Lessee agrees as follows: (1) The Lessee shall not discriminate against any employee or applicant for employment because of race, color, religion, sex, or national origin. The Lessee shall take affirmative action to insure that applicants are employed, and that employees are treated during employment, without regard to their race, color, religion, sex, or national origin. Such action shall include, but not be limited to the following: employment, upgrading, demotion, or transfer; recruitment or recruitment advertising; layoff or termination; rates of pay or other forms of compensation; and selection for training, including apprenticeship. The Lessee shall post in conspicuous places, available to employees and applicants for employment, notices to be provided by the Lessor setting forth the provisions of this Equal Opportunity clause.

(2) The Lessee shall, in all solicitations or advertisements for employees placed by or on behalf of the Lessee, state that all qualified applicants will receive consideration for employment without regard to race, color, religion, sex, or national origin.

(3) The Lessee shall send to each labor union or representative of workers with which he has a collective bargaining agreement or other contract or understanding, a notice, to be provided by the Lessor, advising the labor union or workers' representative of the Lessee's commitments under this Equal Opportunity clause, and shall post copies of the notice in conspicuous places available to employees and applicants for employment.

(4) The Lessee will comply with all provisions of Executive Order No. 11246 of September 24, 1965, as amended, and of the rules, regulations and relevant orders of the Secretary of Labor.

(5) The Lessee shall furnish all information and reports required by Executive Order No. 11246 of September 24, 1965, as amended, and by the rules, regulations, and orders of the Secretary of Labor, or pursuant thereto, and will permit access to his books, records, and accounts by the Secretary of the Interior and the Secretary of Labor for purposes of investigation to ascertain compliance with such rules, regulations, and orders.

(6) In the event of the Lessee's noncompliance with the Equal Opportunity clause of this lease or with any of the said rules, regulations, or orders, this lease may be canceled, terminated or suspended in whole or in part and the lessee may be declared ineligible for further Federal Government contracts or leases in

accordance with procedures authorized in Executive Order No. 11246 of September 24, 1965, as amended, and such other sanctions may be imposed and remedies invoked as provided in Executive Order No. 11246 of September 24, 1965, as amended, or by rule, regulation, or order of the Secretary of Labor, or as otherwise provided by law.

(7) The Lessee shall include the provisions of Paragraphs (1) through (7) of this subsection (a) in every contract, subcontract, or purchase order unless exempted by rules, regulations, or orders of the Secretary of Labor issued pursuant to Section 204 of Executive Order No. 11246 of September 24, 1965, as amended, so that such provisions will be binding upon each contractor, subcontractor or vendor. The Lessee shall taken such action with respect to any contract, subcontract or purchase order as the Secretary may direct as a means of enforcing such provisions, including sanctions for noncompliance: Provided, however, That in the event the Lessee becomes involved in, or is threatened with, litigation with a contractor, subcontractor or vendor as a result of such direction by the Secretary, the lessee may request the lessor to enter into such litigation to protect the interests of the lessor.

(b) Certification of non-segregated facilities. By entering into this lease, the Lessee certifies that Lessee does not and shall not maintain or provide for Lessee's employees any segregated facilities at any of Lessee's establishments, and that Lessee does

not and shall not permit Lessee's employees to perform their services at any location, under Lessee's control, where segregated facilities are maintained. The Lessee agrees that a breach of this certification is a violation of the Equal Opportunity clause in this lease. As used in this certification, the term "segregated facilities" means, but is not limited to, any waiting rooms, work areas, rest rooms and wash rooms, restaurants and other eating areas, time clocks, locker rooms and other storage or dressing areas, parking lots, drinking fountains, recreation or entertainment areas, transportation, and housing facilities provided for employees which are segregated by explicit directive or are in fact segregated on the basis of race, color, religion, or national origin, because of habit, local custom, or otherwise. Lessee further agrees that (except where Lessee has obtained identical certifications from proposed contractors and subcontractors for specific time periods) Lessee shall obtain identical certifications from proposed contractors and subcontractors prior to the award of contracts or subcontracts exceeding $10,000 which are not exempt from the provisions of the Equal Opportunity clause; that Lessee shall retain such certifications in Lessee's files and shall make them available to the Secretary at his request; and that Lessee shall forward the following notice to such proposed contractors and subcontractors (except where the proposed contractor or subcontractor has submitted identical certifications for specific time

periods): Notice to prospective contractors and subcontractors of requirement for certification of non-segregated facilities. A Certification of Non-segregated Facilities, as required by the May 9, 1967, order (32 F.R. 7439, May 19, 1967) on Elimination of Segregated Facilities, by the Secretary of Labor, must be submitted prior to the award of a contract or subcontract exceeding $10,000 which is not exempt from the provisions of the Equal Opportunity clause. The certification may be submitted either for each contract and subcontract or for all contracts and subcontracts during a period (i.e., quarterly, semi-annually, or annually).

Section 20. Taxes

The Lessee shall pay, when due, all taxes lawfully assessed and levied under the laws of the State or the United States upon improvements, output of mines, or other rights, property, or assets of the Lessee.

Section 21. Monopoly and fair prices

The Lessor reserves full authority to promulgate and enforce orders and regulations under the provisions of Sections 30 and 32 of the Act (30 U.S.C. §§187 and 189) necessary to insure that any sale of the production from the Leased Deposits to the United States or to the public is at reasonable prices, to prevent monopoly, and to safeguard the public welfare, and such regulations shall, upon promulgation, be binding upon the Lessee.

Section 22. Suspension of operations or production

Any suspension of operations or production under section 39 of the Act (30 U.S.C. §209) granted with respect to this lease shall take effect as of the first day of the calendar month following the calendar month during which the suspension is approved, except that, in a situation where in the opinion of the Mining Supervisor there is an immediate danger to life, or of irreparable major damage to property or the environment, the Mining Supervisor may grant a suspension effective immediately. The term of any suspension granted pursuant to the Lessee's request with respect to operations or production under this lease shall be in full calendar months. A suspension shall terminate either at the time designated in the suspension order or, if there is no time of termination in the order, at such time as the Mining Supervisor shall designate in subsequent notice to the Lessee.

Section 23. Readjustment of terms and conditions

The Lessor may propose the reasonable readjustment of the terms and conditions of this lease (including royalty provisions), the first readjustment to be effective at the twentieth Anniversary Date of this lease and subsequent readjustments to be effective at twenty Lease Year intervals thereafter. At least 120 days before the appropriate Anniversary Date the Lessor shall give notice to the Lessee of any proposed readjustment of the terms and conditions of the lease and the nature thereof, and, unless the Lessee, within 60

days after receipt of such notice, files with the Lessor an objection to the proposed terms or relinquishes the lease as of the appropriate Anniversary Date, the Lessee shall be deemed conclusively to have agreed to such terms and conditions. If the Lessee files objections with the Lessor, and agreement cannot be reached between the Lessor and the Lessee within a period of 60 days after the filing of the objections, the lease may be terminated by either party upon giving 60 days' notice to the other party; however, the Lessor's right to terminate the lease shall be suspended by the Lessee's filing of a notice of appeal pursuant to Section 34 of this lease. If the Lessee files objections to the proposed readjusted terms and conditions, the existing terms and conditions (other than those concerning royalties) shall remain in effect until there has been an agreement between the Lessor and the Lessee on the new terms and conditions to be incorporated in the lease, or until the Lessee has exhausted his rights of appeal under Section 34 of this lease, or until the lease is terminated; however, the readjusted royalty provisions shall be effective until there is either agreement between the Lessor and the Lessee or until the lease is terminated. If the readjusted royalty provisions are subsequently rescinded or amended, the Lessee shall be permitted to credit any excess royalty payments against royalties subsequently due to the Lessor.

Section 24. Assignment

With respect to the assignment or transfer of any interest under this lease, the Lessee shall comply with the provisions of 43 CFR Subpart 3506 to the same extent as if that Subpart were

specifically applicable to oil shale leases. The Lessor shall have full discretion to approve or disapprove an assignment of this lease, in whole or in part. In particular, the Lessor shall have the right to disapprove any assignment of a divided interest in this lease when either the assigned portion or the retained portion of the lease would, in his opinion, be too small to be economically developed.

Section 25. Overriding royalties

The Lessee shall not create, by assignment or otherwise, an overriding royalty interest in excess of 25 percent of the rate of royalty payable to the United States under this lease or an overriding royalty interest which when added to any other outstanding overriding royalty interest exceeds that percentage, except that, where an interest in the leasehold or in an operating agreement is assigned, the assignor may retain an overriding royalty interest in excess of the above limitation if he shows to the satisfaction of the Department that he has made substantial investments for improvements on the lands covered by the assignment.

Section 26. Heirs and successors in interest

Each obligation hereunder shall extend to and be binding upon, and every benefit shall insure to, the heirs, executors, administrators, successors, or assigns of the respective parties hereto.

Section 27. Unlawful interest

No member of, or Delegate to, Congress, or Resident Commissioner, after his election or appointment, either before or after he

has qualified and during his continuance in office, and no officer, agent, or employee of the Department of the Interior, except as as provided in 43 CFR 7.4(a)(1), shall be admitted to any share or part in this lease or derive any benefit that may arise therefrom; and the provisions of Section 3741 of the Revised Statutes of the United States (41 U.S.C. §22), as amended, and Sections 431, 432, and 433, Title 18 of the United States Code, relating to contracts, enter into and form a part of this lease so far as the same may be applicable.

Section 28. Relinquishment of lease

(a) Upon showing to the satisfaction of the Lessor that he has complied with the terms and conditions of this lease, the Lessee may relinqish the entire lease or any legal subdivision of the Leased Lands.

(b) A relinquishment must be filed, in duplicate, in the proper Bureau State Office. Upon its acceptance it shall be effective as of the date it is filed, subject to the continued obligation of the lessee and his surety, in accordance with the terms and conditions of this lease, (1) to make payment of all accrued bonus payments, rentals, and royalties, except as provided in section 5; (2) to provide for the preservation of any mines, *in situ* production works, underground development works, other permanent improvements, and other property, whether fixtures or personalty, on the Leased Lands; (3) to provide for the recla-

mation of lands and waters affected by exploration or mining operations under this lease; and (4) to comply with all other applicable requirements of this lease.

Section 29. Remedies in case of default

If the Lessee shall fail to comply with any of the terms and conditions of this lease (including the terms and conditions of any development plan approved under section 10) and that default shall continue for a period of 30 days after service of notice thereof by the Lessor, the Lessor may (1) suspend operations until the required action is taken to correct noncompliance, or (2) institute appropriate proceedings in a court of competent jurisdiction for the forfeiture and cancellation of this lease as provided in Section 31 of the Act (30 U.S.C. §188) and for forfeiture of any applicable bond. If the Lessee fails to take prompt and necessary steps to prevent loss or damage to the mine, property, or premises, or to prevent danger to the employees, or to avoid, or, where avoidance is impracticable, to minimize and, where practicable, repair damage to the environment, or, if immediate action by the Lessor, without waiting for action by the Lessee, is required for any of those purposes, the Lessor may enter on the premises and take such measures as he may deem necessary to prevent such loss, damage, or danger, or to correct the damaging, dangerous, or unsafe condition of the mine or any other facilities upon the Leased Lands, and those measures shall be at the expense of the Lessee.

Section 30. Effect of waiver

A waiver of any breach of the provisions of this lease shall extend only to that particular breach and shall not limit the rights of the parties with respect to any future breach. A waiver of a particular cause of forfeiture shall not prevent cancellation of this lease for any other cause, or for the same cause occurring at another time.

Section 31. Delivery of premises in case of forfeiture

In case of the termination of this lease in any manner the Lessee shall deliver to the Lessor, in the condition required by the reclamation requirements of approved exploration and development plans, and subject to the provisions of section 32 of this lease, the Leased Lands, including permanent improvements and other property on the Leased Lands, whether affixed to the ground or movable, and all underground shafts and timbering, well casing, and such other supports and structures as are necessary for the preservation of the Leased Lands, or any mines, other underground development works, or deposits in the Leased Lands.

Section 32. Disposition of property upon termination of lease

(a) Upon termination of this lease in any manner all underground timbering and any other supports or structures which the Lessor shall inform the Lessee are necessary for the preservation of any mines or other underground development works shall become and remain thereafter a part of the realty without the payment of any compensation

to the Lessee. All other structures, equipment, machinery, tools, appliances, and materials on the Leased Lands, whether affixed to the ground or movable, shall remain the property of the Lessee upon the termination of this lease, but the Lessee shall have no right, for a period of six months following the termination, to remove from the Leased Lands any of that property which in the opinion of the Lessor is useful for the protection of the Leased Lands (including any mines in those lands) unless the Lessor shall expressly authorize the removal. During that six-month period the Lessor shall have the right to purchase at the appraised value any or all items of that property required or useful for the protection of the Leased Lands and their use. The appraised value shall be fixed by three disinterested and competent persons (one to be designated by the Lessor, one by the Lessee, and the third by the two so designated), and the appraised value determined by the three or a majority of them shall be conclusive.

(b) At any time within a period of 90 days after either the Lessor has informed the Lessee that he will not purchase the property or the expiration of the 6-month period, the Lessee shall have the right to remove from the premises the property which was not purchased by the Lessor.

(c) Any structures, machinery, equipment, tools, applicances, and materials, subject to removal by the Lessee as provided above, which are allowed to remain on the Leased Lands shall become the

property of the Lessor on expiration of the 90-day period or any extension of that period which may be granted by the Lessor because of adverse climatic conditions or other good and sufficient reason, unless the Lessor shall direct the Lessee to remove any or all of such property on expiration of the 90-day period. If the Lessor directs the Lessee to remove such property, the Lessee shall do so at his own expense or, if he fails to do so within a reasonable period, the Lessor may do so at the Lessee's expense.

Section 33. Lessee's liability to the Lessor

(a) The Lessee shall be liable to the United States for any damage suffered by the United States in any way arising from or connected with activities and operations conducted pursuant to this lease, except where damage is caused by employees of the United States acting within the scope of their authority.

(b) The Lessee shall indemnify and hold harmless the United State from any and all claims arising from or connected with its activities and operations under this lease.

Section 34. Appeals

The Lessee shall have the right of appeal (a) under 43 CFR 3000.4 from any action or decision of any official of the Bureau, (b) under 30 CFR 231.74 from any action, order, or decision of any official of the Geological Survey, or (c) under applicable regulation from any action or decision of any other official of the Department, arising in connection with this lease, including any action or decision pursuant to section 23 of this lease with respect

to the readjustment of terms and conditions.

Section 35. Interpretation of this lease

(a) The paragraph headings in this lease are for convenience only, and do not purport to, and shall not be deemed to, define, limit, or extend the scope or intent of the paragraph to which they pertain.

(b) As used in this lease, unless the context clearly indicates otherwise, a word in the masculine or neuter form shall be interpreted as equally applicable to the masculine, feminine, and neuter genders, and words in singular form shall be interpreted as equally applicable to singular and plural numbers.

THE UNITED STATES OF AMERICA

BY ______________________________
(Authorized Officer)

____
(Title)

Witnesses to Signature of Lessee(s) ______________________________
(Date)

______________________________ ______________________________
(Signature of Lessee)

______________________________ ______________________________
(Signature of Lessee)

______________________________ ______________________________
(Signature of Lessee)

OIL SHALE LEASE ENVIRONMENTAL STIPULATIONS

SECTION 1. GENERAL

(A) Applicability of Stipulations

The terms, conditions, requirements and prohibitions imposed upon Lessee by these Stipulations are also imposed upon Lessee's agents, employees, contractors, and sub-contractors, and their employees. Failure or refusal of Lessee's agents, employees, contractors, sub-contractors, or their employees to comply with these Stipulations shall be deemed to be the failure or refusal of the Lessee. Lessee shall require its agents, contractors, and sub-contractors to include these Stipulations in all contracts and sub-contracts which are entered into by any of them, together with a provision that the other contracting party, and its agents, employees, contractors and sub-contractors, and the employees of each of them, shall likewise be bound to comply with these Stipulations.

(B) Changes in Conditions

These Stipulations are based on existing knowledge and technology. They may be revised or amended by mutual consent of the Mining Supervisor and the Lessee at any time to adjust to changed conditions or to correct an oversight. The Lessor may amend these stipulations at any time without the consent of the Lessee in order to make these stipulations consistent with any new Federal or

State statutes for the protection of the environment upon their enactment and with regulations issued under those statues. The Lessee, the Mining Supervisor, and the Bureau District Manager shall meet at least once a year to review advances in technology and, in a mutual endeavor, weigh, and decide the feasibility and need of revising or amending existing Stipulations.

The Lessor and the Lessee agree that, in this mutual endeavor to decide upon the feasibility and need for amending the existing Stipulations, they will act in good faith and in a sincere effort to make the Lessee's activities under the lease as free from environmental damage as is practicable. Toward this end, systems which require pollution control devices shall possess sufficient flexibility to adopt improved technology at practicable intervals and shall be constructed with the understanding that continued compliance with changing pollution control laws is required.

(C) Collection of Environmental Data and Monitoring Program

(1) The Lessee shall compile data to determine the conditions existing prior to any development operations under the lease and shall, except as provided below, conduct a monitoring program before, during, and subsequent to development operations. The Lessee shall conduct the monitoring program to provide a record of changes from conditions existing prior to development operations, as established by the collection of baseline data, a continuing check on compliance with the provisions of the lease (including these attached Stipulations)

and all applicable Federal, State, and local environmental protection and pollution control requirements, timely notice of detrimental effects and conditions requiring correction, and a factual basis for revision or amendment of these Stipulations pursuant to section 1(B) hereof. Both the types of baseline and subsequent data required and the methods to be used for the collection of the baseline data and the conduct of the monitoring program shall be those set forth in paragraph (2) of this subsection. The baseline data shall be collected for a period of at least two consecutive full years, one full year of which shall be prior to the submission of the detailed development plan under section 10(a) of this lease. If the detailed development plan is submitted prior to the collection of the second year's data, the plan already submitted shall, at the discretion, or with the approval, of the Mining Supervisor, be modified as necessary as a result of study of the additional baseline data. Exploratory operations, as approved by the Mining Supervisor, shall be permitted during the collection of the baseline data. All records of baseline data and subsequent monitoring required by this subsection shall be submitted to the Mining Supervisor at intervals to be prescribed by him.

(2) In collecting baseline data and conducting a monitoring program the Lessee shall adopt the following methods and shall collect the information required below. Wherever the number and placing of testing installations are not given, they shall be as

determined by the Lessee, but subject to being changed as required by the Mining Supervisor. After the collection of the required baseline data for at least two years, the Lessee shall not be required to conduct a monitoring program on the Leased Lands until a date six months prior to the commencement of development operations. The monitoring program shall, thereafter, be conducted until the Mining Supervisor has determined to his satisfaction that environmental conditions have been established after the termination of development operations which are consistent with the requirements of applicable Federal and State statutes and regulations; however, the Mining Supervisor may terminate this requirement at an earlier date where it is in the public interest.

(a) Surface water. The Lessee shall construct gauging stations on the major drainages on the Leased Lands and, as required by the Mining Supervisor, upstream and downstream from the Leased Lands. Data collected at the stations shall include continuous streamflow records, continuous water temperature records, periodic analyses for selected inorganic and organic chemical constituents, as directed by the Mining Supervisor, continuous precipitation records, and continuous sediment records. The Lessee shall maintain records of all information obtained under this paragraph (2)(a).

(b) Ground water. At each proposed or actual mine site, the Lessee shall drill a test well and shall install an observation

well in each water-bearing zone defined by the test well. The Lessee shall collect samples of drill cuttings and shall make borehole geophysical logs as directed by the Mining Supervisor. The Lessee shall isolate each water-bearing zone penetrated by the test wells and pump each of the zones for the period required by the Mining Supervisor. During pump tests the Lessee shall record the water-level fluctuations in each of the observation wells, maintain steady, continuous discharge from the test well, and record the discharge measurements. The Lessee shall maintain records of water level and temperature on each test well and on each observation well pursuant to a measurement schedule specified by the Mining Supervisor. At the initial pump test of each well the Lessee shall determine the water quality of that well by analyzing water samples for organic and inorganic chemical constituents, including, without limitation, trace constituents subject to drinking water standards and water pollution control regulations. The Mining Supervisor may require analysis of samples for such additional constituents as he may deem desirable. After the initial test, the Lessee shall collect water samples from each well at six-month intervals and analyze them for evidence of trends in water quality as determined by comparing the samples with previous analyses.

The Lessee shall complete one observation well upgradient from each disposal site and at least two observation wells downgradient from the site at depths and locations specified by the Mining

Supervisor. The Mining Supervisor may require additional observation wells if there is evidence that they are needed to provide adequate monitoring of the water quality of an aquifer. The Lessee shall record water levels and temperatures in each observation well pursuant to a measurement schedule established by the Mining Supervisr. The Lessee shall determine the water quality of each observation well by analyzing samples for organic and inorganic chemical constituents, including, without limitation, trace constituents subject to drinking water standards and water pollution controls. The Mining Supervisor may require analysis of samples for such additional constituents as he may deem desirable. After the initial test of an observation well the Lessee shall collect water samples from that well at six-month intervals and analyze them for evidence of trends in water quality as determined by comparing the samples with previous analyses.

The Lessee shall maintain records of all information obtained under this paragraph (2)(b).

(c) Air Quality. In the collection of baseline data, the Lessee shall monitor air quality over at least 90 percent of one full calendar year, using four strategically-located stations. One of the stations shall be at the expected point of maximum concentration, or as close to that expected point of maximum concentration as feasible.

The Lessee shall monitor air quality for sulphur dioxide,

hydrogen sulphide, and suspended particulates, using automatic instruments with continuous recorders, where applicable. The Lessee shall also monitor, under the same conditions, hydrocarbons, oxides of nitrogen, and other pollutants, where the Mining Supervisor has determined that such monitoring is necessary to determine baseline air quality or to conduct an effective monitoring program. In addition, the Lessee shall establish a meteorological station in reasonable proximity to each proposed plant to monitor, at least 95 percent of the time over each lease year during which monitoring is required, wind direction and speed (vane and anemometer) and humidity at three levels, one at least 100 feet above the plant, one at approximately 30 feet above the plant, and one at ground level, and termperature at two levels, one at least 100 feet above the plant, and one at approximately 30 feet above the plant. The Lessee shall maintain records of all baseline data collection and monitoring programs.

(d) Flora and Fauna. The Lessee shall make studies of the flora and fauna of the leased lands and of all other lands lying within a mile of the leased lands, and of all lands to be used for disposal of residues from mining and processing oil shale and also of the aquatic habitat as far downstream as the Mining Supervisor shall require. These studies will determine the distribution and density of the flora in these areas and periodically determine the condition of such flora. These studies shall also determine

the species of fauna, their distribution, and their abundance at bi-monthly intervals. The Lessee shall submit a report to the Mining Supervisor of the baseline data obtained and, during the monitoring program, shall submit semi-annual reports to the Mining Supervisor showing whether or not there has been any change. The Lessee shall also study, and report to the Mining Supervisor on ecological inter-relationships including migratory patterns of birds, mammals, and fish, and plant animal relationships. The Lessee shall compile an inventory of natural surface water features, such as springs and seeps.

(3) The environmental monitoring program shall be an integral part of the detailed development plan required in Section 10 of the lease, and at the time of the submission of the plan the Lessee shall provide the Mining Supervisor with a complete compilation of the baseline data collected above and the record of the monitoring program for any period subsequent to the conclusion of that compilation.

(4) Not more than one year after obtaining approval of the detailed mining plan and on each subsequent anniversary date the Lessee shall submit to the Mining Supervisor a report of the base-line data collected and a report on the monitoring programs as a part of the required annual progress reports on the development program. This portion of the annual report will be subject to public review and comment.

(D) Emergency Decisions

Any decisions or approvals of the Mining Supervisor required by these Stipulations to be in writing may in emergencies be issued orally, with written confirmation as soon thereafter as possible.

(E) Environmental Briefing

During the life of this Lease, Lessee shall provide that such Federal and State employees as may be designated by the Mining Supervisor shall brief personnel on environmental and other pertinent matters. The Lessee shall provide for such briefings upon the request of the Mining Supervisor, but the Mining Supervisor shall request only such briefings as may be reasonably necessary to effectuate the provisions of this Lease. Lessee shall make arrangements for the time, place, and attendance at such briefings. Lessee shall bear all costs of such briefings other than salary, per diem, subsistence and travel costs of Federal and State employees.

(F) Construction Standards

The general design of all buildings and structures shall comply with the latest edition of the Uniform Building Code (U.B.C.). Structural steel shall be designed in accordance with the latest edition of the American Institute of Steel Construction "Specifications for Design, Fabrication and Erection of structural Steel for Buildings." Reinforced concrete shall comply with the latest edition of the American Concrete Institute's "Building Code

Requirements for Reinforced Concrete." Engineering works for impoundments shall conform to standard engineering practice sufficient to withstand the 100-year flood in the drainage in which installed.

(G) Housing and Welfare of Employees

In the exercise of his right under section 2 of the Lease to construct buildings and other facilities for the housing and welfare of his employees, the Lessee shall at all times make certain that these facilities are situated, constructed, operated, and maintained in an orderly manner, satisfactory to the Mining Supervisor. While no general restriction is imposed upon the construction of facilities necessary to the employees' health and well-being, such construction shall be subject to the Mining Supervisor's approval and shall not unreasonably damage the environment of the leased lands.

(H) Posting of Stipulations and Plans

The Lessee shall insure that copies of these Stipulations and any approved exploration and development plans are available at the operating sites and for inspection by all on-the-ground operating personnel.

SECTION 2. ACCESS AND SERVICE FACILITIES

(A) Transportation Corridor Plans

The Lessee shall provide corridor plans for roads, pipelines and utilities for approval by the Mining Supervisor. Each plan shall

include probable major design features and plans for the protection of the environment, prevention of pollution, minimization of erosion, rehabilitation and revegetation of all disturbed areas not required in operation of the transportation system, both during and after construction. The Lessee shall, to the maximum extent practicable, make use of multi-use corridors for roads, pipelines and utilities.

(B) Regulation of Public Access

After road construction is completed, the Lessee shall, upon consultation with the Lessor, permit reasonable, free and unrestricted public access to and upon the road and rights-of-way for all lawful and proper purposes except in plant sites, mine sites, disposal areas, and other operational areas which may be closed to the general public. The Lessee shall regulate public access and public vehicular traffic as required to facilitate operations and to protect the public and, to the extent reasonable, livestock and wildlife from hazards associated with construction. For this purpose the Lessee shall provide warnings, flagmen, barricades, and other safety measures as necessary. Whenever the Mining Supervisor shall determine that the Lessee's regulation of access and traffic is unreasonable, or that the Lessee's provision of safety measures is inadequate, he shall so inform the Lessee who shall immediately take corrective measures.

(C) Existing and Planned Roads and Trails

Where feasible, the Lessee shall use existing roads and trails. Unless the Mining Supervisor shall direct otherwise, roads and trails shall be located, constructed, maintained, and closed according to the specifications of the Bureau of Land Management and shall include drainage structures where needed.

(D) Waterbars and Breaks

The Lessee shall divert runoff from roads and uphill slopes by means of waterbars, waterbreaks, or culverts constructed in accordance with Bureau specifications.

(E) Pipeline Construction Standards

The Lessee shall follow the following standards (wherever they may be made applicable) in the design and construction of oil pipelines and the choice of materials for them, and, if these standards should ever be revised, supplemented, or replaced, shall follow the new standards in new construction:

(1) U.S.A. Standard Code (USA Standards Institute) for Pressure Piping, Liquid Petroleum Transportation Piping Systems (USAS B31.4-1966);

(2) U.S.A. Standard Code for Pressure Piping, Gas Transmission and Distribution Piping Systems (USAS B31.8-1968); and

(3) American Society for Testing and Materials (ASTM) standards for the appropriate steel tubing as given in the latest

Book of ASTM Standards, Part 1 or plastic pipe, Part 26.

(F) Pipeline Safety Standards

The Lessee shall meet, where applicable, the safety standards and reporting requirements set forth in the following, as now in effect and as hereafter amended, or, if these regulations should be superseded, the regulations or other rules superseding them:

(1) 49 CFR, Part 110, Carriers by Pipeline (Other than Natural Gas and Water);

(2) 49, CFR, Part 190, Interim Minimum Federal Safety Standards for the Transmission of Natural Gas and Other Gas by Pipeline;

(3) 49 CFR, Part 195, Transmission of Liquids by Pipeline.

(G) Shut-Off Valves

The Lessee shall insure that oil transportation pipeline designs provide for automatic shut-off valves at each pumping or compressor station and such additional valves as may be necessary in view of:

(1) Terrain and drainage systems traversed;

(2) Population centers;

(3) Wildlife and fishery habitat;

(4) Public water supplies and significant water bodies;

(5) Hazardous geologic areas; and

(6) Scenic Values.

The Lessee shall install any additional valves required by the Mining Supervisor.

(H) Pipeline Corrosion

With regard to oil transportation pipelines, the Lessee shall submit detailed plans to the Mining Supervisor for corrosion-resistant design and methods for early detection of pipeline corrosion. These shall include: (1) pipe material and welding techniques to be used and information on their particular suitability for the environment involved; (2) details on the external pipe protection to be provided (coating, wrapping, etc.), including information on variation of the coating process to cope with variations in environmental factors; (3) plans for cathodic protection including details of impressed ground sources and controls to insure continuous maintenance of adequate protection over the entire surface of the pipe; (4) details of plans for monitoring cathodic protection current including spacing of current monitors; and (5) provision for periodic surveys of trouble spots, regular preventive maintenance surveys, regular surveys for external and internal deterioration which may result in failure, and special provisions for abnormal potential patterns resulting from crossings with other pipelines or cables.

(I) Electric Transmission Facilities

The Lessee shall design and construct telegraph, telephone, electric powerlines, distribution lines and other transmission facilities in accordance with the guidelines set forth in "Environmental Criteria for Electric Transmission Systems" (U.S.D.I., U.S.D.A.,

1970), as now or in the future amended, or, if these guidelines should be superseded, in the guidelines or other rules superseding them. Distribution lines shall be designed and constructed in accordance with REA Bulletin 61-10 (Powerline Contacts by Eagles and other Large Birds), as now or in the future amended, or, if these guidelines should be superseded, in the guidelines or other rules superseding them.

(J) Natural Barriers

Where a road or exploratory site cuts a natural barrier used for livestock control, the Lessee shall, at his own expense, close the opening by the use of a fence or other suitable barrier meeting Bureau standards.

(K) Specifications for Fences, and Cattleguards

Fences and cattleguards constructed by the Lessee shall meet established Bureau specifications and standards.

(L) Crossings

The Lessee shall take all steps necessary to make certain that roads constructed under this lease do not prevent or unreasonably disrupt the use of existing roads, foot trails, pipelines, and other rights-of-way or major animal migration routes. This requirement shall include the construction of suitable overhead or underground crossings where they are determined to be necessary by the Mining Supervisor.

(M) Alternate Routes

If during construction the Lessee's activities shall interfere with the free use of existing roads and trails used by persons, whether or not recorded, he shall provide such alternate roads and trails as the Mining Supervisor may determine to be needed.

(N) Off-Road Vehicle Use

The Lessee shall use off-road vehicles in a manner consistent with applicable regulations.

SECTION 3. FIRE PREVENTION AND CONTROL

(A) Instructions of the Mining Supervisor

(1) The Lessee shall comply with the instructions and directions of the Mining Supervisor concerning the use, prevention and suppression of fires, and shall make every reasonable effort to prevent, control and suppress any fire on land subject to the lease. Uncontrolled fires must be immediately reported to the Mining Supervisor.

(2) (a) The Lessee shall construct fire lines or perform clearing when determined by the Mining Supervisor to be necessary for forest, brush and grass fire prevention.

(b) The Lessee shall comply with the National Fire Codes on handling, transportation, storage, use and disposal of flammable liquids, gases, and solids.

(c) The Lessee shall take all appropriate actions to prevent oil shale outcrop fires.

(B) Liability of Lessee

The control and suppression of any fires on the Leased Lands (or on adjoining public lands which have spread from the Leased Lands) caused by the Lessee or his employees, contractors, subcontractors, or agents shall be at the expense of the Lessee. Upon the failure of the Lessee to control and suppress such fires in a manner satisfactory to him, the Mining Supervisor shall take such steps as are necessary to control and suppress the fire, either alone or in conjunction with other Federal, State, and local authorities, and the cost of such control and suppression shall be borne by the Lessee.

SECTION 4. FISH AND WILDLIFE

(A) Management Plan

The Lessee shall submit for approval by the Mining Supervisor, as part of the exploration and mining plan, a detailed fish and wildlife management plan which shall include the steps which the Lessee shall take to: (1) avoid or, where avoidance is impracticable, minimize damage to fish and wildlife habitat, including water supplies; (2) restore such habitat in the event it is unavoidably destroyed or damaged; (3) provide alternate habitats; and (4) provide controlled access to the public for the enjoyment of the wildlife resources on such lands as may be mutually agreed upon. The plan shall include, but not be limited to, detailed information on activities, time schedule, performance standards, proposed

accomplishments, and ways and means of avoiding or minimizing environmental impacts on fish and wildlife.

(B) Mitigation of Damage

Wherever destruction or significant disturbance of fish and wildlife habitat is inevitable, the Lessee shall submit, for the Mining Supervisor's approval at least 60 days prior to the destruction or damage of the habitat, those measures which the Lessee proposes to take to comply with the requirement of 30 CFR 231.4(b), as now in effect or as hereafter amended, or, if that regulation should be superseded, the regulations or other rules superseding it, to avoid, or, where avoidance is impracticable, minimize and repair, injury or destruction of fish and wildlife and their habitat. As a general rule, the proposed measures should provide for habitat of similar type and equal in quantity and quality to that destroyed or damaged. The Mining Supervisor shall, within 60 days after the submission of the proposed measures to him, either approve or disapprove them. If he shall approve them, the Lessee shall execute the proposed measures for the mitigation of the destruction or damage of the habitat. If the Mining Supervisor shall disapprove the measures, he shall offer the Lessee an opportunity for consultation at which, whenever possible, he shall inform the Lessee of any changes which will make the measures acceptable.

(C) Big Game

The Lessee shall construct big game drift fences when and where necessary to direct big game movements around or away from oil shale development areas.

(D) Posting of Notices

The Lessee shall post in reasonable and conspicuous places notices informing its employees, agents, contractors, sub-contractors, and their employees of all applicable laws and regulations governing hunting, fishing, and trapping.

SECTION 5. HEALTH AND SAFETY

(A) In General

The Lessee shall take all measures necessary to protect the health and safety of all persons affected by its activities and operations and shall immediately abate any activity or condition which threatens the life of any person or which threatens any person with bodily harm.

(B) Compliance with Federal Health and Safety Laws and Regulations

The Lessee shall comply with the Federal Metal and Non-metallic Mine Safety Act of 1966 (30 U.S.C. §§721-740), as now in effect or as hereafter amended, or, if it should be superseded, with the statute superseding it, and the Occupational Health and Safety Act of 1970 (29 U.S.C. §§651-678), as now in effect, or as hereafter amended, or, if it should be superseded, with the statute superseding

it, and all health and safety standards promulgated pursuant thereto.

(C) Use of Explosives

The Lessee shall insure that all blasting operations, including the purchase, handling, transportation, storage, use, and destruction of blasting agents are performed in conformance with Public Law 91-452, October 15, 1970 (18 U.S.C. §§841-848), as now in effect or as hereafter amended, or, if it should be superseded, with the statute superseding it, and the regulations promulgated thereunder which are now in 26 CFR 181.

SECTION 6. HISTORIC AND SCIENTIFIC VALUES

(A) Cultural Investigations

The Lessee shall, prior to construction or mining, conduct a thorough and professional investigation of any portion of the Leased Lands to be used, including, but not limited to, those areas to be used for mining, processing, or disposal operations or roads, for objects of historic or scientific interest, including, but not limited to, Indian ruins, pictographs and other archeological remains. The Lessee shall report the results of these investigations to the Mining Supervisor before commencing construction and mining operations.

(B) Objects of Historic or Scientific Interest

The Lessee shall not in any activities under this lease appropriate,

remove, injure, deface, or alter any object of antiquity, or of historic, prehistoric, or scientific interest, including, but not limited to, Indian ruins, pictographs, and other archeological remains. Where a question exists as to whether or not an object is of historic, prehistoric, or scientific interest or is an object of antiquity, the Lessee shall report to the Mining Supervisor for a final determination of which he shall inform the Lessee without unnecessary delay.

SECTION 7. OIL AND HAZARDOUS MATERIALS

(A) Spill Contingency Plans

The Lessee agrees to submit spill contingency plans to the Mining Supervisor with the detailed development plan. This plan shall provide for the control of spills or oil or other hazardous substances which for purposes of this Section 7 shall be defined in section 311(a)(14) of the Federal Water Pollution Control Act, as amended (86 Stat. 816, 863), as now in effect or as hereafter amended, or, if it should be superseded, the statute superseding it.

The plans shall conform to this Stipulation and the National Oil and Hazardous Substances Pollution Contingency Plan, 36 FR 16215, August 20, 1971, as now in force or as hereafter amended, or, if it shall be superseded, the document superseding it, and shall: (1) include a description to positive spill prevention efforts which the lessee shall make; (2) include provisions for spill control;

(3) provide for immediate corrective action including spill control and restoration of the affected resource; (4) provide that the Mining Supervisor shall approve any materials or devices used for spill control and shall approve any disposal sites or techniques selected to handle spilled matter; and (5) include separate and specific techniques and schedules for cleanup of spills on land, rivers and streams. As used in this Stipulation, spill control is defined as including detection, location, confinement, and cleanup of the spill.

(B) Responsibility.

If, during operations, any oil or other hazardous substance should be discharged, the control, removal, disposal, and clean up of that substance, wherever found, shall be the responsibility of Lessee. Upon the failure of the Lessee to control, remove, dispose of, or clean up that discharge, or to repair all damages resulting therefrom, the Mining Supervisor may take such measures as he deems necessary to control, remove, dispose of, or clean up the discharge and restore the area, including, where appropriate, the aquatic environment and fish and wildlife habitats, at the full expense of the Lessee. Such action by the Mining Supervisor shall not relieve Lessee of any responsibility as provided in this lease.

(C) Reporting of Spills and Discharges.

The Lessee shall give immediate notice of any spills or discharges

of oil or other hazardous substances to: (1) the Mining Supervisor and (2) such other Federal and State officials as are required by law to be given such notice. Any oral notice shall be confirmed by the Lessee in writing as soon as possible.

(D) Storage and Handling.

The Lessee shall store oil, petroleum products, industrial chemicals and similar toxic or volatile materials in durable containers and locate such materials so that any accidental spillage will not drain into water courses, lakes, reservoirs, or ground water. Unless otherwise approved by the Mining Supervisor, the Lessee shall store substantial quantities (more than 500 gallons) of such materials in an area surrounded by impermeable containment structures. The volume of the containment structures shall be at least: (1) one-hundred fifty (150) percent of the total storage volume of storage tanks in the relevant area; plus (2) a volume sufficient for maximum trapped precipitation and run-off which might be impounded at the time of a spill.

(E) Pesticides and Herbicides.

The Lessee shall not use pesticides and herbicides without the approval of the Mining Supervisor. Pesticides and herbicides shall be considered treatments of last resort, to be used only when reasonable alternatives are not available and where their use is consistent with protection and enhancement of the environment. Where pesticides and herbicides are used, they shall be used only with the approval of the Mining Supervisor and the type, amount, method of application, storage, and disposal shall be in accordance with applicable Federal and State procedures.

SECTION 8. POLLUTION--AIR

(A) Air Quality.

The Lessee shall utilize and operate all facilities and devices in such a way as to avoid, or, where avoidance is impracticable, minimize air pollution. At all times during construction and operation, Lessee shall conduct its activities in accordance with all applicable air quality standards and related plans of implementation adopted pursuant to the Clean Air Act, as amended (40 U.S.C. §§ 1857-1857-1), as now in effect or as hereafter amended, or if it should be superseded, the statute superseding it, and applicable State standards.

(B) Dust.

The Lessee shall make every reasonable effort to avoid, or, where avoidance is impracticable, minimize dust problems. Where necessary, sprinkling, oiling, or other means of dust control shall be required on roads and trails. The Lessee shall conduct processing operations so as not to create environmental or health problems associated with dust.

(C) Burning.

The Lessee shall not burn waste, timber, or debris, except when disposal is essential and other methods of disposal would be more harmful to the environment and when authorized by the Mining Supervisor.

SECTION 9. POLLUTION--WATER

(A) Water Quality.

The Lessee shall utilize and operate all facilities and devices in such a way as to avoid or, where avoidance is impracticable, minimize water pollution. At all times during construction and operation, Lessee shall conduct its activities in accordance with all applicable Federal and State water quality standards and related plans of implementation, as then in force. Where applicable Federal and State standards do not exist, the Mining Supervisor may establish reasonable standards to prevent degradation of water, and the Lessee shall comply with those standards. The Lessee shall not discharge waste water into any aquifer deemed by the Mining Supervisor to be a potentially valuable water supply nor into any aquifer which will discharge the waste into a surface stream.

(B) Disturbance of Existing Waters.

All construction activities, exclusive of actual mining activities, that may cause the creation of new lakes, drainage of existing ponds, diversion of natural drainages, alternation of stream hydraulics, disturbance of areas of stream beds or degradation of land and water quality or adversely affect the environmental integrity of the area are prohibited unless approved in writing by the Mining Supervisor.

(C) Control of Waste Waters.

In areas where overburden, water, or waste from mines or processing plants might contain toxic or saline materials, the Lessee shall:

(1) Divert surface or ground water so as to avoid the formation of toxic and saline water and its drainage into streams, or, where avoidance is impracticable, to minimize the formation of such waters and drainage, by preventing the entry or reducing the flow of water into the workings, waste piles, or overburden-storage areas;

(2) Dispose of refuse and spent shale from mining and processing in a manner which will avoid the discharge of toxic drainage or saline water into surface or ground water;

(3) Employ, upon termination of operations of any mine, all practicable mine-closing measures consistent with ecological principles and safety requirements in order to avoid the formation and discharge of toxic or saline water;

(4) Dispose of toxic and saline water derived from mining, processing, or refining operations in a manner that does not pollute surface or ground waters;

(5) During mining operations, monitor spoil and refuse for the presence of materials likely to yield unacceptable alkaline, acidic, saline, or toxic solutes; and

(6) Reinject no water, except in compliance with Federal and State standards then in effect and where authorized to do so by the Mining Supervisor.

(D) Cuts and Fills.

The Lessee shall not cut or fill near or in streams which will result in siltation or accumulation of debris unless approved in writing by the Mining Supervisor.

(E) Crossings.

The location of crossings of perennial streams, lakes and rivers must be approved in writing by the Mining Supervisor. To control erosion, the Lessee shall maintain buffer strips at least 200 feet wide on each side of a stream in their natural and undisturbed state unless otherwise authorized in writing by the Mining Supervisor.

(F) Road Surfacing Material.

All road surfacing material used by the Lessee must be approved by the Mining Supervisor.

SECTION 10. POLLUTION--NOISE

The Lessee shall comply with all applicable Federal and State standards on noise pollution, as now in effect or as hereafter amended, or, if they should be superseded, the standards superseding them. In the absence of specific noise pollution standards, the Lessee shall keep noise at or below levels safe and acceptable for humans, as determined by the Mining Supervisor.

SECTION 11. REHABILITATION

(A) In General.

The Lessee shall, in accordance with approved plans rehabilitate all affected lands to a usable and productive condition consistent with or equal to pre-existing land uses in the area and compatible with existing, adjacent undisturbed natural areas. Rehabilitation methods include, but are not limited to, the following: leveling, backfilling, covering the surface with topsoil, and revegetating the spoil banks and pit areas consistent with sound restoration methods. The Lessee shall leave reclaimed land in a usable, non-hazardous condition such that soil erosion and water pollution are avoided or minimized. The Lessee shall, to the extent practicable, conduct such backfilling, leveling and grading concurrently with the mining operations. Upon removal of property at termination of the Lease pursuant to Sections 31 and 32 of the Lease, the Lessee shall, in accordance with approved plans complete the restoration of affected lands to a usable and productive condition consistent with or equal to pre-existing land uses in the area and compatible with existing adjacent undisturbed natural areas.

(B) Management Plan.

The Lessee shall submit for approval by the Mining Supervisor an erosion control and surface rehabilitation plan as part of any exploration or development plan. The initial plan shall be submitted

not less than 60 days prior to start of mining site preparation and updated each year thereafter before March 15. The plan shall include, but not be limited to, detailed information on activities, areas, time schedules, standards, accomplishments, and methods of eliminating or minimizing oil shale development impacts. The Lessee shall base erosion control plans and procedures on a maximum 50-year precipitation rate characteristic of the area. If a 50-year rate is not available the Lessee shall use data based on the longest period of reliable information. Procedures and plans shall consider flash flood effects, mud flows, mudslides, landslides, rock falls, and other similar types of material mass movements.

(C) Stabilization of Disturbed Areas.

The Lessee shall leave all disturbed areas in a stabilized condition. Stabilization practices shall include, as determined by the needs of specific sites: seeding; planting; mulching; and the placement of mat binders, soil binders, rock or gravel blankets or other such structures. Seeding and planting shall be repeated, as often as the Mining Supervisor shall deem reasonable, if prior attempts to revegetate are unsuccessful. All trees, snags, stumps or other vegetative material, not having commercial, ecological, wildlife, or construction value, shall be considered for mechanical chipping and spreading in a manner that will aid seeding establishment and soil stabilization.

(D) Surface Disturbance On-Site.

The Lessee shall correct surface disturbance which may induce soil movement or water pollution, or both, whether during or after construction or mining, in accordance with the surface rehabilitation plan.

(E) Areas of Unstable Soils.

The Lessee shall, where possible, avoid areas having soils that are susceptible to slides and slips, excessive settlement, severe erosion and soil creep during construction or operation. When such areas cannot be avoided the Lessee shall design construction to insure maximum stability. The Lessee shall make soil foundation investigations in conjunction with construction activities. The Lessee shall make such data available to the Mining Supervisor upon request.

(F) Materials.

The Lessee shall, when feasible, utilize waste rock from the mining operations for road beds, fills and other similar construction purposes. When not feasible, gravel and other construction materials shall be purchased in accordance with 43 CFR 3610, as now in effect or as hereafter amended, or, if it shall be superseded, the regulation or rule superseding it, except that the sale of such materials from stream beds and upland soil areas shall be avoided unless otherwise approved by the Mining Supervisor.

(G) Slopes of Cut and Fill Areas.

To the extent consistent with good mining practice, the Lessee shall maintain all cut and fill slopes in a stable condition for the duration of the Lease.

(H) Impoundments.

The Lessee shall establish safe access to permanent water impoundments for persons, lifestock, and wildlife, but, where consumption of such water would be harmful to humans or the use of such water would be detrimental to animals, he shall take necessary steps to prevent access by those to whom it would be harmful or detrimental.

(I) Flood Plains.

The Lessee shall not construct improvements or conduct operations in flood plains or stream drainages when it is reasonable to expect risk to human life, pollution damage, or destruction of the existing environment caused by flood damage, without the express permission of the Mining Supervisor and without providing for protection of any such improvements constructed.

(J) Land Reclamation.

The Lessee shall, unless otherwise directed by the Mining Supervisor, backfill, level, final grade, cover with topsoil and initiate revegetation of each segment of the operation area in

accordance with the rehabilitation plan as soon as that segment is no longer needed, but not later than one year after completion of the particular operation unless an alternative schedule has been approved by the Mining Supervisor.

(K) <u>Overburden</u>.

The Lessee shall, unless otherwise directed by the Mining Supervisor, separate overburden material and stockpile it separately as to topsoil, subsoil, and rock material for later use as fill and as top dressing for rehabilitation of disturbed areas.

(L) <u>Revegetation</u>.

(1) The Lessee shall revegetate all portions of the Leased Lands which have been disturbed by his operations as soon as possible after the disturbance has ended in order to prevent, or, if prevention is impracticable, to minimize erosion and related problems. The Lessee shall restore the vegetation of disturbed areas by reestablishing permanent vegetation of a quality which will support fauna of the same kinds and in the same numbers as those existing at the time the base line data was obtained under section 1(C) of these Stipulations. Plans for revegetation, including species, density, and timing, must be submitted to the Mining Supervisor for approval. The Mining Supervisor may require any reasonable methods of revegetation, and, if he deems it

desirable, may require the Lessee to fence areas to assist revegetation. However, if the Lessor determines, at the time of submission of the detailed development plan under section 10(a) of this lease, that the Leased Lands will, upon the termination of the lease, be put to a different use from that to which they were devoted immediately prior to the issuance of this lease, the Mining Supervisor may require the Lessee to revegetate the land to meet that objective, except that the Lessee shall not be required to expend more money than that needed to meet the first revegetation standard.

(2) The Lessee shall initiate a revegetation program approved by the Mining Supervisor at the start of production to (1) delineate those parameters necessary to establish vegetation at a specific location and (2) show that successional changes in vegetation are compatible with the requirements under subparagraph (1) above.

(3) The Lessee shall demonstrate at the time of submission of the detailed development plan under section 10(a) of this lease that revegetation technology is available to enable him to provide the revegetation of the disturbed areas which is required under paragraph (1) of this subsection. If, in the opinion of the Mining Supervisor, the Lessee has failed to demonstrate the required technology, he shall be required to submit for approval a program designed to obtain the required technology. If the program to obtain the necessary technology is satisfactory, the Mining Supervisor may approve the Lessee's development plan submitted under section 10(a),

but, if the Lessee has not demonstrated the necessary technology by the tenth Anniversary Date after the Lease Year in which the development plan under section 10(a) was approved, the Lessee shall cease all exploratory, development, and production operations under that plan until he has demonstrated that the necessary technology is available to him. The Lessee shall report annually to the Mining Supervisor on the progress of this approved program to obtain the required technology. If the progress appears inadequate at any time, the Mining Supervisor may request the Lessee to amend the program. Whenever the Lessee has demonstrated the necessary technology, the required program shall terminate. Where the Mining Supervisor finds the Lessee has conducted his program to obtain technology, including any requested amendments, in a diligent manner and has expended funds in excess of $500,000 on that program, the Secretary may determine the expenditures in excess of that figure to be extraordinary costs within the terms of section 7(d) of the lease and may credit those excess expenditures against any present or future royalties due the lessor, provided the results of the program are made public.

SECTION 12. SCENIC VALUES

(A) Scenic Considerations in General.

The Lessee shall, except where the Mining Supervisor has approved otherwise, use the following standards in all designing, clearing, earthmoving, and construction:

(1) Contours compatible with the natural environment shall be used to avoid straight lines.

(2) Natural colors consistent with the local environment such as pastels or muted shades of brown, green, reds, or greys shall be used in painting of facilities installed on the lease. Bright or unnatural colors shall be avoided except for use in warning signs or signals.

(3) Small natural openings or the edges of larger openings in the natural environment shall be utilized in construction of facilities, or disturbing the land surface.

(4) During the time when the land is disturbed, the portion of land which is not under revegetation programs shall only be those areas required under the mining plan for mining, storage, processing, or disposal operations.

(5) Contouring of the disturbed areas for reclamation shall simulate natural opening or areas consistent with the surrounding topography.

(B) Consideration of Aesthetic Values.

The Lessee shall consider existing aesthetic values in all planning, construction, reclamation and mining operations. All operations, including, but not limited to, design and construction of roads, pipelines and transmission lines, shall, where practicable, be performed so as to minimize visual impact, make use of the natural topography, and to achieve harmony with the landscape.

(C) Protection of Landscape.

The Lessee shall design any structures and facilities built under this Lease so that they will, to the extent practicable, blend with the natural landscape.

(D) Signs.

The Lessee shall design and construct signs that are rustic in appearance and conform to BLM sign standards.

SECTION 13. VEGETATION

(A) In General.

(1) The Lessee shall reserve from cutting and removal all timber and other vegetative material outside the clearing boundaries and all blazed, painted or posted trees which are on or mark the clearing boundaries, with the exception of danger trees or snags designated as such by the Mining Supervisor.

(2) The Lessee shall insure that all trees, snags or other woody material cut in connection with clearing operations are felled into the right-of-way and away from live water courses.

(B) Timber.

The Lessee shall deal with timber in accordance with the following: clearing and grubbing limits shall be approximately 5 ft. outside of the edge of any cut or fill; where practicable, trees, snags, stumps or other woody material not having wildlife value or value to the Lessee shall be mechanically chipped and spread in a manner that will aid seeding establishment and soil stabilization; clearing boundaries shall be identified on the ground prior to clearing operations.

(C) Clearing and Stripping.

The Lessee may clear and strip only such land as is necessary for mining, processing, disposal, and other operations under the lease. In connection with such operations the Lessee may clear and strip land necessary for roadbeds, but such roadbed widths shall be not more than 25 feet from the centerline unless otherwise specified by the Mining Supervisor.

SECTION 14. WASTE DISPOSAL

(A) Mine Waste.

The Lessee shall, in accordance with the detailed development plan under section 10(a) of this lease, backfill or reclaim excavated material and spent shale and shall compact it thoroughly by machinery to avoid or, where avoidance is impossible, minimize erosion. The Lessee shall design slope faces of waste piles to insure slope stability and shall revegetate slope faces in accordance with the rehabilitation plan.

(B) Other Disposal Areas.

The term "waste" as used in this subsection (B) means all waste other than mine waste. In accordance with approved plans, the Lessee shall collect, recycle or dispose of waste in sanitary land fills or other disposal areas, and shall use the best practicable portable or permanent waste disposal systems, as approved by the Mining Supervisor. The Lessee shall remove or otherwise dispose of all waste in a manner acceptable to the Mining Supervisor, and in accordance with all applicable standards and guidelines of the State, the United States Public Health Service and the Environmental Protection Agency.

(C) Disposal of Solid and Liquid Wastes.

The Lessee shall design and construct disposal systems for solid and liquid wastes so as to avoid landslides, control erosion by wind and water, and establish conditions conducive to vegetative growth in the disposal area. The Lessee shall select and prepare disposal sites for wastes so as to avoid downward percolation of leached products and other pollutants into aquifers.

(D) Impoundment of Water.

No disposal of mine waste, other waste, or the residue from any activity under this Lease shall be disposed of in a manner which could cause an impoundment of water unless plans for spillways and means of diversion and the prevention of both surface and underground water contamination have been prepared by the Lessee and approved by the Mining Supervisor, and the Lessee has complied with those plans.

(E) Slurry Waste Disposal.

Whereever slurry waste disposal is used, the Lessee shall provide impoundments sufficient to contain landslides, mud flows, or waste pile blowouts.

B. OFF-TRACT STIPULATIONS

for Proposed

OIL SHALE PROTOTYPE PROGRAM

Stipulations to be made a part of any lease, permit, license, or other instrument which may be issued by the Department of the Interior in connection with the proposed Oil Shale Prototype other than an oil shale lease itself.

An oil shale lessee or any other party will have to make separate applications for rights-of-way for roads, power transmission lines, telephone and telegraph lines, and pipelines and for special land use permits and other rights to use land outside the tract subject to the oil shale lease for purposes connected directly or indirectly with oil shale development. The environmental stipulations which will be included in such leases, permits, licenses, or other instruments issued under the public land laws for the conduct of activities and operations in connection with an oil shale lease but not pursuant to the oil shale lease itself may very somewhat with the type of lease, permit, license, or other instrument at issue.

However, the following stipulations will be included in such instruments wherever they may be applicable.

(1) All the environmental stipulations set forth above for inclusion in the oil shale lease with the substitution of the term "Authorized Officer" for "Mining Supervisor" wherever the latter term appears and with the following specific exceptions as to subsections:

(a) Section 1(A) - insert "(2)" before present text and add the Section 1(A)(1) below;

(b) Section 1(B) - the fourth sentence should begin: "The Lessee, the Mining Supervisor, and the Authorized Officer shall meet . . . " It should be noted that this is the only place in the off tract Stipulations where "Mining Supervisor" appears;

(c) Section 1(C) - delete references to the detailed development plan and other references to mining operations;

(d) Section 1(G) - delete "his right under section 2 of the Lease" and substitute "any right under his Lease";

(e) Section 1(H) - delete "and any approved exploration and development plans";

(f) Section 4(B) - delete entirely, but see 2(e) below;

(g) Section 4(C) - delete entirely, but see 2(c) below;

(h) Section 5(B) - delete all reference to the Federal Metal and Non-metallic Mine Safety Act of 1966 (30 U.S.C. §§ 721-740);

(i) Section 7(A) - delete the words "with the detailed development plan" in the first sentence;

(j) Section 11(A) - delete "pursuant to Sections 31 and 32 of the Lease" in the last sentence;

(k) Section 11(B) - delete "as part of any exploration or development plan" in the first sentence; and

(1) Section 11(G) - delete "To the extent consistent with good mining practice" and "for the duration of the Lease".

(2) The following additional stipulations:

(a) Insert the following in subsection (A) of Section 1:

(1) These Stipulations shall apply to all activities and operations which are conducted in connection with activities and operations under an oil shale lease, but which are themselves conducted under a different lease, permit, license, or other instrument issued under the public land laws of the United States. The word "Lessee" as used in these Stipulations shall mean the person, association, or corporation holding such a lease, permit, license, or other instrument which has been issued under the public land laws in connection with activities and operations under an oil shale lease, but which is distinct from an oil shale lease. The word "Authorized Officer" means the District Manager of the Bureau of Land Management or his representative or such other officer as may have been designated by the Secretary of the Interior to execute duties under the instrument.

(b) Add the following new subsection to Section 2:

<u>Public Improvements</u>.

The Lessee shall protect existing telephone, telegraph and transmission lines, roads, trails, fences, ditches, and similar improvements during all activities and operations conducted pursuant to this Lease. The Lessee shall not obstruct any road or trail without the approval of the Authorized Officer. Damage caused by Lessee to public utilities and improvements shall be promptly repaired by the Lessee to a condition which is satisfactory to the Authorized Officer.

(c) Add the following new subsections to Section 4:

<u>Big Game</u>.

The Lessee shall conduct all operations under this Lease so as to assure free passage and movements of big game animals and protect wildlife from hazards. The Lessee shall construct big game drift fences when and where necessary to direct big game movements around or away from hazardous development areas.

<u>Fish Migration</u>.

(1) The Lessee shall provide for uninterrupted and safe upstream or downstream passage of fish. The

Lessee shall not erect or construct any artificial structure or stream channel change that causes a permanent blockage to movement of fish.

(2) Unless otherwise provided for by appropriate State or Federal authority, the Lessee shall perform culvert construction in water crossings by the use of procedures and standards designed to avoid interference with fish movements, including, but not limited to, the following:

(a) Water velocities at medium discharge shall not exceed two (2) feet per second in any part of the culvert.

(b) Installation shall whenever possible be at zero gradient with the bottom of the outlet six (6) inches below the natural streambed to prevent erosion at the downstream end of the culvert.

(c) Where outfall erosion is unavoidable, a stilling basin of dimensions sufficient to achieve settling shall be constructed at the

outflow end of the culvert. The pool sides shall be stabilized by means of rip-rap or other appropriate methods to prevent erosion.

(d) In order to reduce sedimentation, diversion of water around the work area in the streambed may be required during installation of a culvert.

(e) Abandoned water diversion structures shall be plugged and stabilized to prevent trapping or stranding of fish.

(f) Stream preservation and improvement structures shall be in accordance with BLM Manual 6760, as now or in the future amended.

Fish Spawning Areas.

"Fish spawning areas" means the areas where fish deposit their eggs. The Lessee shall protect spawning areas from sediment from all sources of construction or mining activity. Where soil material is expected to be suspended in water as a result of construction or mining activities, the Lessee shall construct sediment settling basins or take other appropriate measures to permit the removal of silt before it reaches a stream or lake. Special requirements may be made by the Authorized

Officer for each stream system to protect spawning areas. The Lessee shall repair all damage to fish spawning beds caused by construction or operation activities.

Use of Explosives.

The Lessee shall not, without prior approval of the Authorized Officer, use explosives in areas designated by the Authorized Officer as closed to the use of explosives during the times specified in the notice of designation. This designation shall be made at the time of the issuance of the instrument granting the Lessee the right to use the area, and shall be made only to protect fish spawning or rearing areas, nesting areas, lambing grounds, fawning grounds, and strutting sites during periods of intense activity.

(d) Add the following new subsection to Section 11:

Surface Disturbance Off-Site.

The Lessee shall (1) eliminate or minimize off-site vegetative or surface disturbance to the extent that such elimination or minimization is consistent with practical construction operations, and (2) as soon as feasible, rehabilitate all disturbed areas

to conform as nearly as practicable with the adjacent terrain and revegetate all areas adjacent to utility corridors or roads the surface of which has been disturbed.

(e) Insert the following new subsection (B) in Section 4:

(B) Mitigation of Damage.

Wherever destruction or significant disturbance of fish and wildlife habitat is inevitable, the Lessee shall submit, for the Authorized Officer's approval, those measures which the Lessee proposes to take to avoid, wherever possible, and, where avoidance is impracticable, to minimize and repair injury or destruction of fish and wildlife and their habitat at least 60 days prior to the destruction or damage of the habitat. Unless the Authorized Officer shall indicate otherwise within 60 days after the submission of the proposed measures to him, the measures will be deemed approved and thereafter the Lessee will execute the proposed measures for the mitigation of the destruction or damage of the habitat.

Title 43—PUBLIC LANDS: INTERIOR

Subtitle A—Office of the Secretary of the Interior

[Circular No 2259]

PART 23—SURFACE EXPLORATION, MINING AND RECLAMATION OF LANDS

A new Part 23 is hereby added to Title 43 Code of Federal Regulations, to become effective upon publication in the FEDERAL REGISTER.

§ 23.1 Purpose.

It is the policy of this Department to encourage the development of the mineral resources under its jurisdiction where mining is authorized. However, the public interest requires that, with respect to the exploration for, and the surface mining of, such minerals, adequate measures be taken to avoid, minimize, or correct damage to the environment—land, water, and air—and to avoid, minimize, or correct hazards to the public health and safety. The regulations in this part prescribe procedures to that end.

§ 23.2 Scope.

(a) Except as provided in paragraphs (b) and (c) of this section, the regulations in this part provide for the protection and conservation of nonmineral resources during operations for the discovery, development, surface mining, and onsite processing of minerals under permits, leases, or contracts issued pursuant to: The Mineral Leasing Act of February 25, 1920, as amended (30 U.S.C. 181–287); the Mineral Leasing Act for Acquired Lands (30 U.S.C. 351–359); the Materials Act of July 31, 1947, as amended (30 U.S.C. 601–604); and title 23, United States Code, section 317, relating to appropriation for highway purposes of lands owned by the United States.

(b) The regulations in this part do not cover the exploration for oil and gas or the issuance of leases, or operations thereunder, for oil and gas under the mineral leasing acts, which are covered by regulations in Subpart 3107 and Part 3120 of this title and 30 CFR Part 221; neither do they cover minerals underlying Indian tribal or allotted lands, which are subject to regulations in Title 25 CFR, nor minerals subject to the general mining laws (30 U.S.C. 21–54); nor minerals under the Materials Act which are under the jurisdiction of the Secretary of Agriculture (74 Stat. 205); nor minerals underlying lands, the surface of which is not owned by the U.S. Government.

(c) When more than one permit or contract is expected to be issued to dispose of materials in a particular deposit or tract of land, such as community pits or common use areas, no requirement for reclamation will be made in such permits or contracts and the burden of reclamation will be assumed by the Government. Where reclamation is not required because more than one permit or contract is expected to be issued, there shall be added to the sales price under each permit or contract a reasonable charge to defer the cost of reclamation. In computing such added charge, the authorized officer shall establish the estimated cost of reclamation upon completion of extractive operations for the deposit and the estimated total volume of material to be extracted. The added charge shall be a proportionate share of the estimated cost of reclamation in the same ratio as the material sold under the permit or contract bears to the total estimated volume of the deposit which is expected to be extracted.

(d) The regulations in this part shall apply only to permits, leases, or contracts issued subsequent to the date on which the regulations become effective.

§ 23.3 Definitions.

As used in the regulations in this part:

(a) "Mineral leasing acts" means the Mineral Leasing Act of February 25, 1920, as amended and supplemented (30 U.S.C. 181–287) and the Mineral Leasing Act for Acquired Lands (30 U.S.C. 351–359);

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(b) "Materials Act" means the Act of July 31, 1947, as amended (30 U.S.C. 601-604);

(c) "Mining supervisor" means the Regional Mining Supervisor, or his authorized representative, of the Geological Survey authorized as provided in 30 CFR 211.3 and 231.2 to supervise operations on the land covered by a permit or lease;

(d) "District manager" means the manager of the district office or other authorized officer of the Bureau of Land Management having administrative jurisdiction of and responsibility for the land covered by a permit, lease, contract, application, or offer;

(e) "Overburden" means all the earth and other materials which lie above a natural deposit of minerals and such earth and other materials after removal from their natural state in the process of mining;

(f) "Area of land to be affected" or "area of land affected" means the area of land from which overburden is to be or has been removed and upon which the overburden or waste is to be or has been deposited, and includes all lands affected by the construction of new roads or the improvement or use of existing roads to gain access to an operation and for haulage;

(g) "Operation" means all of the premises, facilities, roads, and equipment used in the process of determining the location, composition or quality of a mineral deposit, or in developing, extracting, or onsite processing of a mineral deposit in a designated area;

(h) "Method of operation" means the method or manner by which a cut or open pit is made, the overburden is placed or handled, water is controlled or affected and other acts performed by the operator in the process of exploring or uncovering and removing or onsite processing of a mineral deposit;

(i) "Holder" or "operator" means the permittee, leasee, or contractor designated in a permit, lease, or contract;

(j) "Reclamation" means measures undertaken to bring about the necessary reconditioning or restoration of land or water that has been affected by exploration or mineral development, mining or onsite processing operations, and waste disposal, in ways which will prevent or control onsite and offsite damage to the environment.

§ 23.4 Application for permission to conduct exploration operations.

No person shall, in any manner or by any means which will cause the surface of lands to be disturbed, explore, test, or prospect for minerals (other than oil and gas) subject to disposition under the mineral leasing acts or the Materials Act without first filing an application for, and obtaining, a permit, lease or contract which authorizes such exploring, testing, or prospecting.

§ 23.5 Technical examination of prospective surface exploration and mining operations.

(a) (1) In connection with an application for a permit or lease under the mineral leasing acts or an application for a permit or an offer to make a contract under the Materials Act, the district manager shall make, or cause to be made, a technical examination of the prospective effects of the proposed exploration or surface mining operations upon the environment. The technical examination shall take into consideration the need for the preservation and protection of other resources, including recreational, scenic, historic, and ecological values; the control of erosion, flooding, and pollution of water; the isolation of toxic materials; the prevention of air pollution; the reclamation by revegetation, replacement of soil, or by other means, of lands affected by the exploration or mining operations; the prevention of slides; the protection of fish and wildlife and their habitat; and the prevention of hazards to public health and safety.

(2) A technical examination of an area should be made with the recognition that actual potential mining sites and mining operations vary widely with respect to topography, climate, surrounding land uses, proximity to densely used areas, and other environmental influences and that mining and reclamation requirements should provide sufficient flexibility to permit adjustment to local conditions.

(b) Based upon the technical examination, the district manager shall formulate the general requirements which the applicant must meet for the protection of nonmineral resources during the conduct of exploration or mining operations and for the reclamation of lands or waters affected by exploration or mining operations. The general requirements shall be made known in writing to the applicant before the issuance of a permit or lease or the making of a contract, and upon acceptance thereof by the applicant, shall be incorporated in the permit, lease, or contract. If an application or offer is made under the Mineral Leasing Act for Acquired Lands and if the lands are under the jurisdiction of an agency other than the Department of the Interior, the requirements must incorporate provisions prescribed by that agency. If the application or offer is made under the Mineral Leasing Act of February 25, 1920, or the Materials Act, and if the lands are under the jurisdiction of an agency other than the Department of the Interior, the district manager shall consult representatives of the agency administering the land and obtain their recommendations for provisions to be incorporated in the general requirements. If the district manager does not concur in the recommendations, the issues shall be referred for resolution to the Under Secretary of the Department of the Interior and the comparable officer of the agency submitting the recommendations. In the case of disagreement on the issues which are so referred, the Secretary of the Interior shall make a determination on the recommendations which shall be final and binding.

(c) In each instance in which an application or offer is made under the mineral leasing acts, the mining supervisor shall participate in the technical examination and in the formulation of the general requirements. If the lands covered by an application or offer are under the jurisdiction of a bureau of the Department of the Interior other than the Bureau of Land Management, the district

manager shall consult representatives of the bureau administering the land. If the lands covered by the application or offer are under the jurisdiction of an agency other than the Department of the Interior and that agency makes a technical examination of the type provided for in paragraph (a) of this section, district managers and mining supervisors are authorized to participate in that examination.

(d) Whenever it is determined that any part of the area described in an application or offer for a permit, lease, or contract is such that previous experience under similar conditions has shown that operations cannot feasibly be conducted by any known methods or measures to avoid—

(1) Rock or landslides which would be a hazard to human lives or endanger or destroy private or public property; or

(2) Substantial deposition of sediment and silt into streams, lakes, reservoirs; or

(3) A lowering of water quality below standards established by the appropriate State water pollution control agency, or by the Secretary of the Interior; or

(4) A lowering of the quality of waters whose quality exceeds that required by the established standards—unless and until it has been affirmatively demonstrated to the State water pollution control agency and to the Department of the Interior that such lowering of quality is necessary to economic and social development and will not preclude any assigned uses made of such waters; or

(5) The destruction of key wildlife habitat or important scenic, historical, or other natural or cultural features; the district manager may prohibit or otherwise restrict operations on such part of an area.

(e) If, on the basis of a technical examination, the district manager determines that there is a likelihood that there will be a lowering of water quality as described in paragraphs (d) (3) and (4) of this section caused by the operation, no lease or permit shall be issued or contract made until after consultation with the Federal Water Pollution Control Administration and a finding by the Administration that the proposed operation would not be in violation of the Federal Water Pollution Control Act, as amended (33 U.S.C. sec. 466 et seq.) or of Executive Order No. 11288 (31 F.R. 9261). Where a permit or lease is involved the district manager's determination shall be made in consultation with the mining supervisor.

(f) Each notice of a proposed appropriation of a materials site filed by the Department of Transportation under 23 U.S.C. 317 shall be transmitted to the proper district manager. The district manager shall cause a technical examination to be made as provided in paragraph (a) of this section and shall formulate the requirements which the State highway department or its nominee must meet. If the land covered by the proposed appropriation is under the jurisdiction of a bureau of the Department other than the Bureau of Land Management, the district manager shall consult representatives of the bureau administering the land. If the district manager determines, or, in an instance in which the land is administered by another bureau, a representative of that bureau determines that the proposed appropriation is contrary to the public interest or is inconsistent with the purposes for which such land or materials are reserved, the district manager shall promptly submit the matter to the Secretary of the Interior for his decision. In other instances, the district manager shall notify the Department of Transportation of the requirements and conditions which the State highway department or its nominee must meet.

§ 23.6 Basis for denial of a permit, lease, or contract.

An application or offer for a permit, lease, or contract to conduct exploratory or extractive operations may be denied any applicant or offeror who has forfeited a required bond because of failure to comply with an exploration or mining plan. However, a permit, lease, or contract may not be denied an applicant or offeror because of the forfeiture of a bond if the lands disturbed under his previous permit, lease, or contract have subsequently been reclaimed without cost to the Federal Government.

§ 23.7 Approval of exploration plan.

(a) Before commencing any surface disturbing operations to explore, test, or prospect for minerals covered by the mineral leasing acts the operator shall file with the mining supervisor a plan for the proposed exploration operations. The mining supervisor shall consult with the district manager with respect to the surface protection and reclamation aspects before approving said plan.

(b) Before commencing any surface disturbing operations to explore, test, or prospect for materials covered by the Materials Act the operator shall file with the district manager a plan for the proposed exploration operations.

(c) Depending upon the size and nature of the operation and the requirements established pursuant to § 23.5 the mining supervisor or the district manager may require that the exploration plan submitted by the operator include any or all of the following:

(1) A description of the area within which exploration is to be conducted;

(2) Two copies of a suitable map or aerial photograph showing topographic, cultural and drainage features;

(3) A statement of proposed exploration methods, i.e. drilling, trenching, etc., and the location of primary support roads and facilities;

(4) A description of measures to be taken to prevent or control fire, soil erosion, pollution of surface and ground water, damage to fish and wildlife or other natural resources, and hazards to public health and safety both during and upon abandonment of exploration activities.

(d) The mining supervisor or the district manager shall promptly review the exploration plan submitted to him by the operator and shall indicate to the operator any changes, additions, or amendments necessary to meet the requirements formulated pursuant to

§ 23.5, the provisions of the regulations in this part, and the terms of the permit.

(e) The operator shall comply with the provisions of an approved exploration plan. The mining supervisor and the district manager may, with respect to such a plan, exercise the authority provided by paragraphs (f) and (g) of § 23.8 respecting a mining plan.

§ 23.8 Approval of mining plan.

(a) (1) Before surface mining operations may commence under any permit or lease issued under the mineral leasing acts the operator must file a mining plan with the mining supervisor and obtain his approval of the plan. Paragraphs (b) through (g) of this section confer authority upon mining supervisors with respect to mining plans pertaining to permits or leases issued under the mineral leasing acts. The mining supervisor shall consult with the district manager with respect to the surface protection and reclamation aspects before approving said plan.

(2) Before surface mining operations may commence under any permit issued or contract made under the Materials Act, the operator must file a mining plan with the district manager and obtain his approval of the plan. Paragraphs (b) through (g) of this section confer authority upon district managers with respect to mining plans pertaining to permits issued or contracts made under the Materials Act.

(b) Depending on the size and nature of the operation and the requirements established pursuant to § 23.5, the mining supervisor or the district manager may require that the mining plan submitted by the operator include any or all of the following:

(1) A description of the location and area to be affected by the operations;

(2) Two copies of a suitable map, or aerial photograph showing the topography, the area covered by the permit, lease, or contract, the name and location of major topographic and cultural features, and the drainage plan away from the area to be affected;

(3) A statement of proposed methods of operating, including a description of proposed roads or vehicular trails; the size and location of structures and facilities to be built;

(4) An estimate of the quantity of water to be used and pollutants that are expected to enter any receiving waters;

(5) A design for the necessary impoundment, treatment or control of all runoff water and drainage from workings so as to reduce soil erosion and sedimentation and to prevent the pollution of receiving waters;

(6) A description of measures to be taken to prevent or control fire, soil erosion, pollution of surface and ground water, damage to fish and wildlife, and hazards to public health and safety; and

(7) A statement of the proposed manner and time of performance of work to reclaim areas disturbed by the holder's operation.

(c) In those instances in which the permit, lease, or contract requires the revegetation of an area of land to be affected the mining plan shall show:

(1) Proposed methods of preparation and fertilizing the soil prior to replanting;

(2) Types and mixtures of shrubs, trees, or tree seedlings, grasses or legumes to be planted; and

(3) Types and methods of planting, including the amount of grasses or legumes per acre, or the number and spacing of trees, or tree seedlings, or combinations of grasses and trees.

(d) In those instances in which the permit, lease, or contract requires regrading and backfilling, the mining plan shall show the proposed methods and the timing of grading and backfilling of areas to be affected by the operation.

(e) The mining supervisor or the district manager shall review the mining plan submitted to him by the operator and shall promptly indicate to the operator any changes, additions, or amendments necessary to meet the requirements formulated pursuant to § 23.5, the provisions of the regulations in this part and the terms of the permit, lease, or contract. The operator shall comply with the provisions of an approved mining plan.

(f) A mining plan may be changed by mutual consent of the mining supervisor or the district manager and the operator at any time to adjust to changed conditions or to correct any oversight. To obtain approval of a change or supplemental plan the operator shall submit a written statement of the proposed changes or supplement and the justification for the changes proposed. The mining supervisor or the district manager shall promptly notify the operator that he consents to the proposed changes or supplement or, in the event he does not consent, he shall specify the modifications thereto under which the proposed changes or supplement would be acceptable. After mutual acceptance of a change of a plan the operator shall not depart therefrom without further approval.

(g) If circumstances warrant, or if development of a mining plan for the entire operation is dependent upon unknown factors which cannot or will not be determined except during the progress of the operations, a partial plan may be approved and supplemented from time to time. The operator shall not, however, perform any operation except under an approved plan.

§ 23.9 Performance bond.

(a) (1) Upon approval of an exploration plan or mining plan, the operator shall be required to file a suitable performance bond of not less than $2,000 with satisfactory surety, payable to the Secretary of the Interior, and the bond shall be conditioned upon the faithful compliance with applicable regulations, the terms and conditions of the permit, lease, or contract, and the exploration or mining plan as approved, amended

or supplemented. The bond shall be in an amount sufficient to satisfy the reclamation requirements of an approved exploration or mining plan, or an approved partial or supplemental plan. In determining the amount of the bond consideration shall be given to the character and nature of the reclamation requirements and the estimated costs of reclamation in the event that the operator forfeits his performance bond.

(2) In lieu of a performance bond an operator may elect to deposit cash or negotiable bonds of the U.S. Government. The cash deposit or the market value of such securities shall be equal at least to the required sum of the bond.

(b) A bond may be a nationwide or statewide bond which the operator has filed with the Department under the provisions of the applicable leasing regulations in Subchapter C of Chapter II of this title, if the terms and conditions thereof are sufficient to comply with the regulations in this part.

(c) The district manager shall set the amount of a bond and take the necessary action for an increase or for a complete or partial release of a bond. He shall take action with respect to bonds for leases or permits only after consultation with the mining supervisor.

§ 23.10 Reports: Inspection.

(a) (1) The holder of a permit or lease under the mineral leasing acts shall file the reports required by this section with the mining supervisor. The holder of a permit or a party to a contract under the Materials Act shall file such reports with the district manager.

(2) The provisions of this section confer authority and impose duties upon mining supervisors with respect to permits or leases issued under the mineral leasing acts and upon district managers with respect to permits issued or contracts made under the Materials Act.

(b) Operations report: Within 30 days after the end of each calendar year, or if operations cease before the end of a calendar year, within 30 days after the cessation of operations, the operator shall submit an operations report containing the following information:

(1) An identification of the permit, lease, or contract and the location of the operation;

(2) A description of the operations performed during the period of time for which the report is filed;

(3) An identification of the area of land affected by the operations and a description of the manner in which the land has been affected;

(4) A statement as to the number of acres disturbed by the operations and the number of acres which were reclaimed during the period of time;

(5) A description of the method utilized for reclamation and the results thereof;

(6) A statement and description of reclamation work remaining to be done.

(c) Grading and backfilling report: Upon completion of such grading and backfilling as may be required by an approved exploration or mining plan, the operator shall make a report thereon and request inspection for approval. Whenever it is determined by such inspection that backfilling and grading has been carried out in accordance with the established requirements and approved exploration or mining plan, the district manager shall issue a release of an appropriate amount of the performance bond for the area graded and backfilled. Appropriate amounts of the bond shall be retained to assure that satisfactory planting, if required, is carried out.

(d) Planting report: (1) Whenever planting is required by an approved exploration or mining plan, the operator shall file a report with the mining supervisor or district manager whenever such planting is completed. The report shall—

(i) Identify the permit, lease, or contract;

(ii) Show the type of planting or seeding, including mixtures and amounts;

(iii) Show the date of planting or seeding;

(iv) Identify or describe the areas of the lands which have been planted;

(v) Contain such other information as may be relevant.

(2) The mining supervisor or district manager, as soon as possible after the completion of the first full growing season, shall make an inspection and evaluation of the vegetative cover and planting to determine if a satisfactory growth has been established.

(3) If it is determined that a satisfactory vegetative cover has been established and is likely to continue to grow, any remaining portion of the performance bond may be released if all requirements have been met by the operator.

(e) Report of cessation or abandonment of operations: (1) Not less than 30 days prior to cessation or abandonment of operations, the operator shall report his intention to cease or abandon operations, together with a statement of the exact number of acres of land affected by his operations, the extent of reclamation accomplished and other relevant information.

(2) (i) Upon receipt of such report the mining supervisor or the district manager shall make an inspection to determine whether operations have been carried out and completed in accordance with the approved exploration or mining plan.

(ii) Whenever the lands in a permit, lease or contract issued under the mineral leasing acts or the Materials Act are under the jurisdiction of a bureau of the Department of the Interior other than the Bureau of Land Management the mining supervisor or the district manager, as appropriate, shall obtain the concurrence of the authorized officer of such bureau that the operation has been carried out and completed in accordance with the approved exploration or mining plan with respect to the surface protection and reclamation aspects of such plan before releasing the performance bond.

(iii) Whenever the lands in a permit, lease or contract issued under the Mineral Leasing Act of 1920 or the Materials Act are under the jurisdiction of an agency other than the Department of the Interior, the mining supervisor or the district manager, as appropriate, shall consult representatives of the agency administering the lands and obtain their recommendations as to whether the operation has been carried out and completed in accordance with the approved exploration or mining plan, with respect

to the surface protection and reclamation aspects of such plan before releasi[illegible] the performance bond. If the mining s[illegible]rvisor or district manager, as appropriate, do not concur in the recommendations of the agency regarding compliance with the surface protection and reclamation aspects of the approved exploration or mining plan, the issues shall be referred for resolution to the Under Secretary of the Department of the Interior and the comparable officer of the agency submitting the recommendations. In the case of disagreement on issues which are so referred, the Secretary of the Interior shall make a determination which shall be final and binding. In cases in which the recommendations are not concurred in by the mining supervisor or district manager, the performance bond shall not be released until resolution of the issues or until a final determination by the Secretary of the Interior.

(iv) Whenever the lands in a permit or lease issued under the Mineral Leasing Act for Acquired Lands are under the jurisdiction of an agency other than the Department of the Interior, the mining supervisor or the district manager, as appropriate, shall obtain the concurrence of the authorized officer of such agency that the operation has been carried out and completed in accordance with the approved exploration or mining plan with respect to the surface protection and reclamation aspects of such plan before releasing the performance bond.

§ 23.11 Notice of noncompliance: Revocation.

(a) The provisions of this section confer authority and impose duties upon mining supervisors with respect to permits or leases issued under the mineral leasing acts and upon district managers with respect to permits issued or contracts made under the Materials Act. The mining supervisor shall consult with the district manager before taking any action under this section.

(b) The mining supervisor or district manager shall have the right to enter upon the lands under a permit, lease, or contract, at any reasonable time, for the purpose of inspection or investigation to determine whether the terms and conditions of the permit, lease, or contract, and the requirements of the exploration or mining plan have been complied with.

(c) If the mining supervisor or the district manager determines that an operator has failed to comply with the terms and conditions of a permit, lease, or contract, or with the requirements of an exploration or mining plan, or with the provisions of applicable regulations under this part the supervisor or manager shall serve a notice of noncompliance upon the operator by delivery in person to him or his agent or by certified or registered mail addressed to the operator at his last known address.

(d) A notice of noncompliance shall specify in what respects the operator has failed to comply with the terms and conditions of a permit, lease, or contract, or the requirements of an exploration or mining plan, or the provisions of applicable regulations, and shall specify the action which must be taken to correct the noncompliance and the time limits within which such action must be taken.

(e) Failure of the operator to take action in accordance with the notice of noncompliance shall be grounds for suspension by the mining supervisor or the district manager of operations or for the initiation of action for the cancellation of the permit, lease, or contract and for forfeiture of the performance bond required under § 23.9.

§ 23.12 Appeals.

(a) A person adversely affected by a decision or order of a district manager or of a mining supervisor made pursuant to the provisions of this part shall have a right of appeal to the Director of the Bureau of Land Management whenever the decision appealed from was rendered by a district manager, or to the Director of the Geological Survey if the decision or order appealed from was rendered by a mining supervisor, and the further right to appeal to the Secretary of the Interior from an adverse decision of either Director unless such decison was approved by the Secretary prior to promulgation.

(b) Appeals to Director, Bureau of Land Management, or to Director, Geological Survey, and appeals to the Secretary shall be made pursuant to procedures and requirements of Parts 1840 and 1850 of this title, except that for the purposes of an appeal taken from a decision or order of a mining supervisor made pursuant to this part:

(1) The term "Director" wherever it occurs in Part 1850 or 1850 of this title shall mean the Director of the Geological Survey.

(2) The term "Field Commissioner" shall include a person designated by the Director of the Geological Survey to hold a hearing.

(3) Whenever the provisions of Parts 1840 and 1850 of this title require that a document be filed in the Office of the Director, such documents shall be filed in the Office of the Director, Geological Survey (Address: Director, Geological Survey, Washington, D.C. 20240).

(c) In any case involving a permit, lease or contract for lands under the jurisdiction of an agency other than the Department of the Interior, or a bureau of the Department of the Interior other than the Bureau of Land Management, the officer rendering a decision or order shall, in the event of an appeal from such decision or order, designate the authorized officer of such agency as an adverse party on whom a copy of a notice of appeal and any statement of reasons, written arguments or briefs must be served.

(d) Hearings to present evidence on an issue of fact before a Field Commissioner designated by the appropriate Director shall be conducted pursuant to the requirements and procedures set forth in Part 1850 of this title.

§ 23.13 Consultation.

Whenever the lands included in a permit, lease, or contract are under the jurisdiction of an agency other than the Department of the Interior or under the jurisdiction of a bureau of the Department of the Interior other than the Bureau of Land Management, the mining supervisor or the district manager, as appropriate, shall consult the authorized officer of such agency before taking any final action under §§ 23.7, 23.8, 23.10 (c) and (d) (2) and (3), and 23.11(c).

DAVID S. BLACK,
Under Secretary of the Interior.

JANUARY 15, 1969.

[F.R. Doc. 69-747; Filed, Jan. 17, 1969; 8:51 a.m.]

D. Operating Regulations for Exploration, Development and Production

federal register

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PART III

DEPARTMENT OF THE INTERIOR

■

GEOLOGICAL SURVEY

■

Operating Regulations for Exploration, Development and Production

No. 106—Pt. III——1

Title 30—MINERAL RESOURCES

Chapter II—Geological Survey, Department of the Interior

PART 231—OPERATING REGULATIONS FOR EXPLORATION, DEVELOPMENT, AND PRODUCTION

On March 24, 1971, a notice and text of a proposed revision of the mining operating regulations, governing operations conducted under mineral permits and leases on public and acquired lands of the United States and Indian lands administered by the Department of the Interior, was published in the FEDERAL REGISTER (36 F.R. 5510-5515) for the following purposes:

(1) To update the existing regulations by deleting obsolete provisions and including requirements consistent with modern mining practices;

(2) To add provisions for the protection of the environment during exploratory and mining operations and for reclamation of lands disturbed by such operations;

(3) To revise the procedure for appeals from decisions of the Mining Supervisors; and

(4) To delete provisions pertaining to health and safety of miners since health and safety standards for metal and nonmetallic mines are now contained in 30 CFR Parts 55, 56, and 57.

Interested parties were given 60 days from the date of publication of the notice within which to submit written comments, suggestions, or objections with respect to the proposed revision. The period for submitting written comments, suggestions, or objections was subsequently extended to July 22, 1971, by a notice published in the FEDERAL REGISTER on June 19, 1971 (36 F.R. 11815). After consideration of the views presented, the following changes have been made in the proposed regulations:

1. In § 231.1, the term "oil shale" has been corrected to read "shale oil" when referring to the extraction of shale oil by in situ methods from oil shale.

2. Section 231.2 has been amended to eliminate the definition of "Chief, Branch of Mining Operations" and to change the definition of "Mining Supervisor." These amendments have been made to reflect the recently approved reorganization of the Conservation Division of the Geological Survey. (Departmental Manual Part 120, Chapter 4; Release No. 1373, December 8, 1971.) For the same reason, the title, "Chief, Branch of Mining Operations" has been deleted in paragraph (a) of § 231.3, and in paragraphs (c) (3) and (4) of that section, the title "Chief, Conservation Division of the Geological Survey" has been substituted for the title "Chief, Branch of Mining Operations."

3. In § 231.3, the provision in paragraph (d) authorizing the Mining Supervisor to consult with or solicit and receive advice of the Environmental Protection Agency pertaining to water pollution problems has been deleted since such matters are more appropriately the subject of a memorandum of understanding between this Department and the Environmental Protection Agency. For the same reason, the provisions in paragraph (e) of this section and in paragraph (d) of § 231.4 with respect to consultation by the Mining Supervisor with the Environmental Protection Agency have been deleted. Paragraph (e) of § 231.3 has been amended to provide that the Mining Supervisor in addition to making inspections to determine the adequacy of water pollution control measures shall also make inspections to determine the adequacy of air pollution control measures.

4. Section 231.4 has been changed to make it clear that a lessee's or permittee's obligation, under paragraph (b), pertaining to damage to the environment, surface improvements, and other values is to "avoid, minimize or repair" such damage, and that determination made by the mining supervisor under paragraph (b) will be subject to appeal. Paragraph (c) has been amended to provide that all operations under the regulations shall be consistent with both Federal and State water and air quality standards.

5. Section 231.10(a) has been changed to require that exploration and mining plans be submitted in quintuplicate rather than in triplicate. This change is necessary to assure that the mining supervisor receives sufficient copies of the plans to permit distribution to other interested agencies.

6. In § 231.10(b), which enumerates the items which the mining supervisor may require be included in an exploration plan, the first 17 words: "Depending on the size and nature of the operations and terms and conditions of the permit * * * ," have been deleted as unnecessary since the authority granted to the mining supervisor to require inclusion of the enumerated item is discretionary. For the same reason, the first 17 words, "Depending on the size and nature of the operation and the terms and conditions of the lease * * *" have been deleted from paragraph (c) of this section which enumerates the items which the mining supervisor may require be included in mining plans. Also, the title of paragraphs (b) and (c) have been changed from "Permits" and "Lease" respectively, to the more descriptive titles, "Exploration Plans" and "Mining Plans." The number of maps or aerial photographs that may be required with exploration and mining plans has been increased from two to five because of the need by the mining supervisor and other interested agencies for additional copies of these items.

7. The requirement of § 231.11 that copies of maps of underground workings and surface operations be submitted on "tracing cloth" has been changed to require that such maps be submitted on "reproducible material." Copies of maps on reproducible material will be adequate for the Mining Supervisor's needs. In the requirement that the accuracy of maps furnished to the Mining Supervisor be certified "by a professional engineer, professional land surveyor, or other qualified person", the word "professionally" has been added between the words "other" and "qualified" to make it clear that the accuracy of such maps shall be certified only by those who are professionally qualified to do so.

8. The requirement of § 231.20(a) that all drill holes be logged "by competent geologists or engineers" has been changed to require that drill holes be logged "under supervision of a competent geologist or engineer." The changed requirement is considered to afford adequate protection to the United States and is consistent with present drilling practices. Section 231.20(a) also has been amended to place a limitation of 1 year on the period an operator is required to retain the core from test holes for inspection since retention for a longer period puts an unnecessary burden on the operator.

9. Section 231.20(b) has been changed to make it clear that drill holes shall be "cemented and/or cased" when abandoned, unless other methods of abandonment are approved in advance by the Mining Supervisor.

10. Section 231.20(d) has been changed to make the requirement for equipping drilling equipment with blowout preventers when drilling on lands valuable or potentially valuable for geothermal resources applicable also when drilling on land valuable or potentially valuable for oil and gas since the danger of blowouts exists in both situations.

11. In the requirement of § 231.30 that operators observe the highest standards while conducting mining operations, the term "good practice following the highest standards" has been substituted for the term "the highest standards." Section 231.30, as originally proposed, amended former § 231.12 by substituting "highest standards" for the term "good practice." It was not the purpose of that change to place on an operator any additional obligations to those required in the former regulation. The present change is being made to make it clear that the requirement that an operator observe "good practice" means that he shall follow the highest standards prevailing in the mining industry.

12. Since pillars may not be the only acceptable method for protection of mine workings and overlying deposits, § 231.31 has been amended to authorize the Mining Supervisor to approve other methods for providing such protection.

13. Section 231.34 has been changed by adding the word "underground" in the first sentence to make it clear that this section, which provides for development of leased lands from a mine on adjoining lands, applies only to underground mines on adjoining lands and not to surface mines. The requirement of paragraph (c) for providing free access for inspection of connecting mines on privately owned or controlled lands "at all hours" has been changed to the more reasonable requirement that such access be provided at "any reasonable time."

14. The requirement of § 231.34 that structures within 100 feet of a mine opening be protected against fire has been changed to add the additional requirement that they be constructed of fire resistent material. This change will add a higher degree of safety and is consistent with a similar requirement in 30 CFR Part 57.

15. Section 231.73 *Enforcement of orders*, has been rewritten to require that the Mining Supervisor serve notice on the operator before suspending operations for failure to comply with regulations, terms, and conditions of the permit or lease, the requirements of approved plans, and instructions of the Supervisor. Such advance notice, however, would not be required if the violation threaten immediate, serious or irreparable harm to the environment, mine, or other resources.

16. Section 231.74 has been changed in several respects for the purpose of clarifying the procedure for appeals from orders of the Mining Supervisor. The section has been amended to provide that appeals from a decision of the Director, Geological Survey, or the Commissioner of Indian Affairs under 30 CFR Part 231, may be taken to the Board of Land Appeals in accordance with the Department hearings and appeals procedures in 43 CFR Part 4.

Other suggestions for changes in the proposed regulations were considered but were not adopted.

Effective date. The amended regulations are hereby adopted to take effect at the beginning of the 30th calendar day following the date of publication in the FEDERAL REGISTER.

Dated: May 26, 1972.

W. T. PECORA,
Acting Secretary of the Interior.

AUTHORITY: The provisions of this Part 231 issued under 35 Stat. 312; 35 Stat. 781, as amended; secs. 32, 6, 26, 41 Stat. 450, 753, 1248; secs. 1, 2, 3, 44 Stat. 301, as amended; secs. 6, 3, 44 Stat. 659, 710; secs. 1, 2, 3, 44 Stat. 1057; 47 Stat. 1487; 49 Stat. 1482, 1250, 1967, 2026; 52 Stat. 347; sec. 10, 53 Stat. 1196, as amended; 56 Stat. 273; sec. 10, 61 Stat. 915; sec. 3, 63 Stat. 683; 64 Stat. 311; 25 U.S.C. 396, 396a–f, 30 U.S.C 189, 271, 281, 293, 359. Interpret or apply secs. 5, 5, 44 Stat. 302, 1058, as amended; 58 Stat. 483–485; 5 U.S.C. 301, 16 U.S.C. 508b, 30 U.S.C. 189, 192c, 271, 281, 293, 359, 43 U.S.C. 387.

ADMINISTRATION OF REGULATIONS AND DEFINITIONS

§ 231.1 Scope and purpose.

(a) The regulations in this part shall govern operations for the discovery, testing, development, mining, and processing of potash, sodium, phosphate, sulphur, asphalt, and oil shale (except for operations for the extraction of shale oil by in situ retorting methods utilizing boreholes or wells) under leases or permits issued for public domain lands pursuant to the regulations in 43 CFR Group 3500. These regulations shall also apply to operations for the discovery, testing, development, mining, and processing of minerals (except coal, oil, and gas) in acquired lands under leases or permits issued pursuant to the regulations in 43 CFR Group 3500 and minerals (except coal, oil, and gas) in tribal and allotted Indian lands leased under the regulations in 25 CFR Parts 171, 172, 173, 174, and 176.

(b) The purpose of the regulations in this part is to promote orderly and efficient prospecting, exploration, testing, development, mining, and processing operations and production practices without waste or avoidable loss of minerals or damage to deposits; to promote the safety, health, and welfare of workmen; to encourage maximum recovery and use of all known mineral resources; to promote operating practices which will avoid, minimize, or correct damage to the environment—land, water and air—and avoid, minimize, or correct hazards to public health and safety; and to obtain a proper record and accounting of all minerals produced.

(c) When the regulations in this part relate to matters included in the regulations in 43 CFR Part 23—Surface Exploration, Mining, and Reclamation of Lands—pertaining to public domain and acquired lands, or 25 CFR Part 177—Surface Exploration, Mining, and Reclamation of Lands—pertaining to Indian lands, the regulations in this part shall be considered as supplemental to the regulations in those parts, and the regulations in those parts shall govern to the extent of any inconsistencies.

CROSS REFERENCE: See Part 211 of this chapter for regulations governing operations under coal permits and leases. See Part 221 of this chapter for regulations governing operations under oil and gas leases and operations for the extraction of shale oil by in situ retorting or other methods utilizing boreholes or wells.

§ 231.2 Definitions.

The terms used in this part shall have the following meanings:

(a) *Secretary*. The Secretary of the Interior.

(b) *Director*. The Director of the Geological Survey, Washington, D.C.

(c) *Mining supervisor*. A registered professional engineer; the representative of the Secretary under administrative direction of the Director through the Chief, Conservation Division, and appropriate Regional Manager, Conservation Division of the Geological Survey, authorized and empowered to regulate operations and to perform other duties prescribed in the regulations in this part, or any subordinate of the Mining Supervisor acting under his direction.

(d) *Lessee*. Any person or persons, partnership, association, corporation, or municipality to whom a mineral lease is issued subject to the regulations in this part, or an assignee of such lease under an approved assignment.

(e) *Permittee*. Any person or persons, partnership, association, corporation, or municipality to whom a mineral prospecting permit is issued subject to the regulations in this part, or an assignee of such permit under an approved assignment.

(f) *Leased lands, leased premises, or leased tract*. Any lands or deposits under a mineral lease and subject to the regulations in this part.

(g) *Permit lands*. Any lands or deposit under a mineral prospecting permit and subject to the regulations in this part.

(h) *Operator*. A lessee or permittee or one conducting operations on the leased or permit lands under the authority of the lessee or permittee.

(i) *Reclamation*. The measures undertaken to bring about the necessary reconditioning or restoration of land or water that has been affected by exploration, testing, mineral development, mining, onsite processing operations, or waste disposal, in ways which will prevent or control onsite and offsite damage to the environment.

§ 231.3 Responsibilities.

(a) Subject to the supervisory authority of the Secretary, the regulations in this part shall be administered by the Director through the Chief, Conservation Division, of the Geological Survey.

(b) The responsibility for health and safety inspections of mines subject to the regulations in this part is vested in the Bureau of Mines in accordance with section 4 of the Federal Metal and Nonmetallic Mine Safety Act (80 Stat. 772, 773; 30 U.S.C. 723) and the Health and Safety Standards contained in Parts 55, 56, and 57, Chapter I, of this title.

(c) The mining supervisor, individually, or through his subordinates is empowered to regulate prospecting, exploration, testing, development, mining, and processing operations under the regulations in this part. The duties of the mining supervisor or his subordinates include the following:

(1) *Inspections; supervision of operations to prevent waste or damage.* Examine frequently leased or permit lands where operations for the discovery, testing, development, mining, or processing of minerals are conducted or are to be conducted; inspect and regulate such operations, including operations at accessory plants, for the purpose of preventing waste of mineral substances or damage to formations and deposits containing them, or damage to other formations, deposits, or nonmineral resources affected by the operations, and insuring that the terms and conditions of the permit or lease and the requirements of the exploration or mining plans are being complied with.

(2) *Compliance with regulations, lease or permit terms, and approved plans.* Require operators to conduct their operations in compliance with the provisions of applicable regulations, the terms and conditions of the leases or permits, and the requirements of approved exploration or mining plans.

(3) *Reports on condition of lands and manner of operations; recommendations for protection of property.* Make reports to the Chief, Conservation Division of the Geological Survey, as to the general condition of lands under permit or lease and the manner in which operations are being conducted and orders or instructions are being complied with, and to submit information and recommendations for protecting the minerals, the mineral-bearing formations and the nonmineral resources.

(4) *Manner and form of records, reports, and notices.* Prescribe, subject to the aproval of the Chief, Conservation Division of the Geological Survey, the manner and form in which records of operations, reports, and notices shall be made.

(5) *Records of production; rentals and royalties.* Obtain and check the records of production of minerals; determine rental and royalty liability of lessees and permittees; collect and deposit rental and royalty payments; and maintain rental and royalty accounts.

(6) *Suspension of operations and production.* Act on applications for suspension of operations or production or both filed pursuant to 43 CFR 3503.3-2(e), and terminate such suspensions which have been granted; and transmit to the Bureau of Indian Affairs for appropriate action applications for suspension of operations or production or both under leases on Indian lands.

(7) *Cessation and abandonment of operations.* Upon receipt of a report of cessation or abandonment of operations, inspect and determine whether the terms and conditions of the permit or lease and the exploration or mining plans have been complied with; and determine and report to the agency having administrative jurisdiction over the lands when the lands have been properly conditioned for abandonment. The mining supervisor, in accordance with applicable regulations, will consult with, or obtain the concurrence of, the authorized officer of the agency having administrative jurisdiction over the lands with respect to compliance by the operator with the surface protection and reclamation requirements of the lease or permit and the exploration or mining plan.

(8) *Trespass involving removal of mineral deposits.* Report to the agency having administrative jurisdiction over the lands any trespass that involves removal of mineral deposits.

(d) Prior to the approval of an exploration or mining plan, the mining supervisor shall consult with the authorized officer of the agency having administrative jurisdiction over the lands with repect to the surface protection and reclamation aspects of the plan.

(e) The mining supervisor shall inspect exploratory and mining operations to determine the adequacy of water management and pollution control measures for the protection and control of the quality of surface and ground water resources and the adequacy of emission control measures for the protection and control of air quality.

(f) The mining supervisor shall issue such orders and instructions not in conflict with the laws of the State in which the leased or permit lands are situated as necessary to assure compliance with the purposes of the regulations in this part.

§ 231.4 General obligations of lessees and permittees.

(a) Operations for the discovery, testing, development, mining, or processing of minerals shall conform to the provisions of applicable regulations, the terms and conditions of the lease or permit, the requirements of approved exploration or mining plans, and the orders and instructions issued by the mining supervisor or his subordinates under the regulations in this part. Lessees and permittees shall take precautions to prevent waste and damage to mineral-bearing formations, and shall take such steps as may be needed to prevent injury to life or health and to provide for the health and welfare of employees.

(b) Lessees and permittees shall take such action as may be needed to avoid, minimize, or repair soil erosion; pollution of air; pollution of surface or ground water; damage to vegetative growth, crops, including privately owned forage, or timber; injury or destruction of fish and wildlife and their habitat; creation of unsafe or hazardous conditions; and damage to improvements, whether owned by the United States, its permittees, licensees or lessees, or by others; and damage to recreational, scenic, historical, and ecological values of the land. The surface of leased or permit lands shall be reclaimed in accordance with the terms and conditions prescribed in the lease or permit and the provisions of the approved exploration or mining plan. Where any question arises as to the necessity for or the adequacy of an action to meet the requirements of this paragraph, the determination of the mining supervisor shall be final, subject to the right of appeal as provided in § 231.74.

(c) All operations conducted under the regulations in this part must be consistent with Federal and State water and air quality standards.

(d) When the mining supervisor determines that a water pollution problem exists, the mining supervisor may require that a lessee or permittee maintain records of the use of water, quantity and quality of waste water produced, and the quantity and quality of waste water disposal, including mine drainage discharge, process wastes and associated wastes. In order to obtain this information, the lessee or permittee may be required to install a suitable monitoring system.

(e) Full reports of accidents, inundations, or fires shall be promptly mailed to the mining supervisor by the operator or his representative. Fatal accidents, accidents threatening damage to the mine, the lands, or the deposits, or accidents which could cause water pollution shall be reported promptly to the mining supervisor by telegram or telephone. The reports required by this section shall be in addition to those required by Parts 55, 56, or 57, Chapter I of this title or other applicable regulations.

(f) Lessees and permittees shall submit the reports required by 25 CFR Part 177; Part 200 of this chapter, and 43 CFR Part 23.

§ 231.5 Public inspection of records.

Geological and geophysical interpretations, maps, and data and commercial and financial information required to be submitted under this part shall not be available for public inspection without the consent of the permittee or lessee so long as the permittee or lessee furnishing such data, or his successors or assignees, continues to hold a permit or lease of the lands involved.

MAPS AND PLANS

§ 231.10 Operating plans.

(a) *General.* Before conducting any operations under a permit or lease, the operator shall submit, in quintuplicate, to the mining supervisor for approval an exploration or mining plan which shall show in detail the proposed exploration, prospecting, testing, development, or mining operations to be conducted. Ex-

ploration and mining plans shall be consistent with and responsive to the requirements of the lease or permit for the protection of nonmineral resources and for the reclamation of the surface of the lands affected by the operations. The mining supervisor shall consult with the other agencies involved, and shall promptly approve the plans or indicate what modifications of the plans are necessary to conform to the provisions of the applicable regulations and the terms and conditions of the permit or lease. No operations shall be conducted except under an approved plan.

(b) *Exploration plans*. The mining supervisor may require that an exploration plan include any or all of the following:

(1) A description of the area within which exploration is to be conducted;

(2) Five copies of a suitable map or aerial photograph showing topographic, cultural, and drainage features;

(3) A statement of proposed exploration methods, i.e., drilling, trenching, etc., and the location of primary support roads and facilities;

(4) A description of measures to be taken to prevent or control fire, soil erosion, pollution of surface and ground water, pollution of air, damage to fish and wildlife or other natural resources, and hazards to public health and safety both during and upon abandonment of exploration activities.

(c) *Mining plans*. The mining supervisor may require that a mining plan include any or all of the following:

(1) A description of the location and area to be affected by the operations;

(2) Five copies of a suitable map, or aerial photograph showing the topography, the area covered by the permit or lease, the name and location of major topographic and cultural features, and the drainage plan away from the area affected;

(3) A statement of proposed methods of operating, including a description of the surface or underground mining methods; the proposed roads or vehicular trails; the size and location of structures and facilities to be built;

(4) An estimate of the quantity of water to be used and pollutants that are expected to enter any receiving waters;

(5) A design for the necessary impoundment, treatment or control of all runoff water and drainage from workings so as to reduce soil erosion and sedimentation and to prevent the pollution of receiving waters;

(6) A description of measures to be taken to prevent or control fire, soil erosion, pollution of surface and ground water, pollution of air, damage to fish and wildlife or other natural resources, and hazards to public health and safety;

(7) A statement of the proposed manner and time of performance of work to reclaim areas disturbed by the operations.

(d) *Revegetation; regrading; backfilling*. In those instances in which the permit or lease requires the revegetation of an area to be affected by operations the exploration or mining plan shall show:

(1) Proposed methods of preparation and fertilizing the soil prior to replanting;

(2) Types and mixtures of shrubs, trees, or tree seedlings, grasses or legumes to be planted; and

(3) Types and methods of planting, including the amount of grasses or legumes per acre, or the number and spacing of trees, or tree seedlings, or combinations of grasses and trees.

If the permit or lease requires regrading and backfilling, the exploration or mining plan shall show the proposed methods and the timing of grading and backfilling of areas of lands affected by the operations.

(e) *Changes in plans*. Exploration and mining plans may be changed by mutual consent of the mining supervisor and the operator at any time to adjust to changed conditions or to correct an oversight. To obtain approval of a changed or supplemental plan the operator shall submit a written statement of the proposed changes or supplement and the justification for the changes proposed.

(f) *Partial plan*. If circumstances warrant, or if development of an exploration or mining plan for the entire operation is dependent upon unknown factors which cannot or will not be determined except during the progress of the operations, a partial plan may be approved and supplemented from time to time. The operator shall not, however, perform any operation except under an approved plan.

§ 231.11 Maps of underground workings and surface operations and equipment.

Maps of underground workings and surface operations shall be drawn to a scale acceptable to the mining supervisor. All maps shall be appropriately marked with reference to Government land marks or lines and elevations with reference to sea level. When required by the mining supervisor vertical projections and cross sections shall accompany plan views. Maps shall be based on accurate surveys made at least annually and as may be necessary at other times. Accurate copies of such maps on reproducible material or prints thereof shall be furnished the mining supervisor when and as required. The maps shall be posted to date and submitted to the mining supervisor at least once each year. The accuracy of maps furnished shall be certified by a professional engineer, professional land surveyor, or other professionally qualified person.

§ 231.12 Other maps.

(a) The operator shall prepare such maps of the leased lands as in the judgment of the mining supervisor are necessary to show the surface boundaries, improvements, and topography, including subsidence resulting from mining, and the geological conditions so far as determined from outcrops, drill holes, exploration or mining. All excavations in each separate bed or deposit shall be shown in such manner that the production of minerals for any royalty period can be accurately ascertained.

(b) In the event of the failure of the operator to furnish the maps required, the mining supervisor shall employ a competent mine surveyor to make a survey and maps of the mine, and the cost thereof shall be charged to and promptly paid by the operator.

(c) If any map submitted by an operator is believed to be incorrect, the mining supervisor may cause a survey to be made, and if the survey shows the map submitted by the operator to be substantially incorrect in whole or in part, the cost of making the survey and preparing the map shall be charged to and promptly paid by the operator.

BORE HOLES AND SAMPLES

§ 231.20 Core or test hole, cores, samples, cuttings, mill products.

(a) The operator shall submit promptly to the mining supervisor signed copies, in duplicate, of records of all core or test holes made on the leased or permit lands, the records to be in such form that the position and direction of the holes can be accurately located on a map. The records shall include a log of all strata penetrated and conditions encountered, such as water, quicksand, gas, or unusual conditions, and copies of analyses of all samples analyzed from strata penetrated shall be transmitted to the mining supervisor as soon as obtained or at such time as specified by the mining supervisor. All drill holes will be logged under supervision of a competent geologist or engineer, and the lessees will furnish to the mining supervisor a detailed lithologic log of each drill hole and all other in-hole surveys, such as electric logs, gamma ray neutron logs, sonic logs or any other logs produced. The core from test holes shall be retained by the operator for 1 year and shall be available for inspection at the convenience of the mining supervisor, and he shall be privileged to cut such cores and receive samples of such parts as he may deem advisable, or on request of the mining supervisor the operator shall furnish such samples of strata, drill cuttings, and mill products as may be required.

(b) Drill holes for development or holes for prospecting shall be abandoned to the satisfaction of the mining supervisor by cementing and/or casing or by other methods approved in advance by the mining supervisor and in a manner to protect the surface and not to endanger any present or future underground operation or any deposit of oil, gas, other mineral substances, or water strata.

(c) At the option of the mining supervisor or the operator drill holes may be converted to surveillance wells for the purpose of determining the effect of subsequent operations upon the quantity, quality, or pressure of ground water or mine gases.

(d) When drilling on lands valuable or potentially valuable for oil and gas or geothermal resources drilling equipment shall be equipped with blowout control devices acceptable to the mining supervisor before penetrating more than 100

feet of consolidated sediments unless a greater depth is approved in advance by the mining supervisor.

WELFARE AND SAFETY

§ 231.25 Sanitary, welfare, and safety arrangements.

The underground and surface sanitary, welfare, health, and safety arrangements shall be in accordance with the recommendations of the U.S. Public Health Service and the applicable standards in Parts 55, 56, and 57, Chapter I of this title.

CROSS REFERENCE: For regulations of the U.S. Public Health Service, Department of Health, Education, and Welfare, see 42 CFR Chapter I.

MINING METHODS

§ 231.30 Good practice to be observed.

The operator shall observe good practice following the highest standards in prospecting, exploration, testing, development, and mining, sinking wells, shafts, and winzes, driving drifts and tunnels, stoping, blasting, transporting ore and materials, hoisting, the use of explosives, timbering, pumping, and other activities on the leased or permit lands.

§ 231.31 Ultimate maximum recovery; information regarding mineral deposits.

(a) Mining operations shall be conducted in a manner to yield the ultimate maximum recovery of the mineral deposits, consistent with the protection and use of other natural resources and the protection and preservation of the environment—land, water, and air. All shafts, main exits, and passageways, as well as overlying beds or mineral deposits that at a future date may be of economic importance, shall be protected by adequate pillars in the deposit being worked or by such other means as approved by the mining supervisor.

(b) Information obtained regarding the mineral deposit being worked and other mineral deposits on the leased or permit lands shall be fully recorded and a copy of the record furnished to the mining supervisor.

§ 231.32 Pillars left for support.

Sufficient pillars shall be left in first mining to insure the ultimate maximum recovery of mineral deposits when the time arrives for the removal of pillars. Boundary pillars shall in no case be less than 50 feet thick unless otherwise specified in writing by the mining supervisor. Boundary and other main pillars shall be mined only with the written consent or by order of the mining supervisor or his authorized subordinates.

§ 231.33 Boundary pillars and isolated blocks.

(a) If the ore on adjacent lands subject to these regulations has been worked out beyond any boundary pillar, if the water level beyond the pillar is below the lessee's adjacent operations, and if no other hazards exist, the lessee shall, on the written demand of the mining supervisor, mine out and remove all available ore in such boundary pillar, both in the lands covered by the lease and in the adjoining premises, when the mining supervisor determines that it can be mined without undue hardship to the lessee.

(b) If the mining rights in adjoining premises are privately owned or controlled, an agreement may be made with the owners of such interests for the extraction of the ore in the boundary pillars.

(c) Narrow strips of ore between leased lands and the outcrop on other lands subject to these regulations and small blocks of ore adjacent to leased lands that would otherwise be isolated or lost may be mined under the provisions specified in paragraphs (a) and (b) of this section.

§ 231.34 Development on leased tract through adjoining mines as part of a mining unit.

A lessee may mine his leased tract from an adjoining underground mine on land privately owned or controlled or from adjacent leased lands, under the following conditions:

(a) A mine that is on the land privately owned or controlled shall conform to all sections in the regulations in this part.

(b) The only connections between the mine on land privately owned or controlled and the mine on leased land shall be the main haulageways, the ventilationways, and the escapeways. Substantial concrete frames and fireproof doors that may be closed in an emergency and opened from either side shall be installed in each such connection. Other connections through the boundary pillars shall not be made until both mines are about to be exhausted and abandoned. The mining supervisor may waive any of the requirements in this paragraph when, in his judgment, such a waiver would not conflict with the regulations in Part 57, Chapter I of this title and would not entail substantial loss of ore.

(c) Free access for inspection of said connecting mine on land privately owned or controlled shall be given at any reasonable time to the mining supervisor or other representative of the Secretary of the Interior.

(d) If a lessee operating on a lease through a mine on land privately owned or controlled does not maintain the mine in accordance with the operating regulations, operations on the leased land may be ordered stopped or departmental seals applied by the mining supervisor, and the operations on leased lands shall be stopped.

§ 231.35 Minerals soluble in water; brines; mineral taken in solution.

In mining or prospecting deposits of potassium or other minerals soluble in water, all wells, shafts, prospect holes, and other openings shall be adequately protected with neat cement or other suitable materials against the coursing or entrance of water; and the operator shall, on orders of the mining supervisor, backfill with rock or other suitable material to protect the roof from breakage when there is a danger of the entrance of water. On leased or permit lands containing brines, due precaution shall be exercised to prevent the deposits becoming diluted or contaminated by the mixture of water or valueless solution. Where minerals are taken from the earth in solution, such extraction shall not be within 500 feet of the boundary line of the leased lands without the written permission of the mining supervisor.

PROTECTION AGAINST MINE HAZARDS

§ 231.40 Surface openings.

(a) The operator shall substantially fill in, fence, protect or close all surface openings, subsidence holes, surface excavations or workings which are a hazard to people or animals. Such protective measures shall be maintained in a secure condition during the term of the permit or lease. Before abandonment of operations all openings, including water discharge points, shall be closed to the satisfaction of the mining supervisor.

(b) Reclamation or protection of surface areas no longer needed for operations should commence without delay. The mining supervisor shall designate such areas where restoration or protective measures, or both, must be taken.

§ 231.41 Abandonment of underground workings.

No underground workings or part thereof shall be permanently abandoned and rendered inaccessible without the advance and written approval of the mining supervisor.

§ 231.42 Flammable gas and dust.

Mines in which flammable gas is found or explosive dust produced shall be subject to the coal-mining operating regulations in Part 211 of this chapter. An "explosive dust" is a combustible solid in airborne dispersion capable of propagating flame when ignited.

§ 231.43 Fire protection.

All structures within 100 feet of any mine opening shall be protected against fire and constructed of fire resistant material. Flammable material shall not be stored within 100 feet of a mine exit. All shafts shall be fireproof, or adequate fire-control devices, satisfactory to the mining supervisor, shall be installed. All underground offices, stations, shops, magazines, and stores shall be so constructed, equipped, and maintained as to reduce the fire hazard to a minimum. Sufficient fire-fighting apparatus shall be maintained in working condition at the mine exits and at convenient points in the mine workings for fire emergencies. An adequate water supply shall be held in storage tanks or reservoirs for fire emergencies and shall be available for immediate use through connecting pipelines for either surface or underground fires.

MILLING; WASTE FROM MINING OR MILLING

§ 231.50 Milling.

It shall be the duty of the operator to conduct milling operations pursuant to the terms of the lease, the approved mining plan, and the regulations in this part and to use due diligence in the reduction, concentration, or separation of mineral substances by mechanical or chemical

processes, by distillation, by evaporation, or other means so that the percentage of salts, concentrates, oil, or other mineral substances recovered shall be in accordance with approved practices.

§ 231.51 **Disposal of waste.**

The operator shall dispose of all wastes resulting from the mining, reduction, concentration, or separation of mineral substances in accordance with the terms of the lease, approved mining plan, the regulations in this part, and the directions of the mining supervisor.

PRODUCTION RECORDS AND AUDIT

§ 231.60 **Books of account.**

Operators shall maintain books in which will be kept a correct account of all ore and rock mined, of all ore put through the mill, of all mineral products produced, and of all ore and mineral products sold and to whom sold, the weight, assay value, moisture content, base price, dates, penalties, and price received, and the percentage of the mineral products recovered and lost shall be shown.

CROSS REFERENCE: See Part 200 of this chapter for reports required to be filed and the forms to be used.

§ 231.61 **Royalty basis.**

The sale price basis for the determination of the rates and amount of royalty shall not be less than the highest and best obtainable market price of the ore and mineral products, at the usual and customary place of disposing of them at the time of sale, and the right is reserved to the Secretary of the Interior to determine and declare such market price, if it is deemed necessary by him to do so for the protection of the interests of the lessor.

§ 231.62 **Audits.**

An audit of the lessee's accounts and books may be made annually or at such other times as may be directed by the mining supervisor, by certified public accountants, and at the expense of the lessee. The lessee shall furnish free of cost duplicate copies of such annual or other audits to the mining supervisor, within 30 days after the completion of each auditing.

INSPECTION, ISSUANCE OR ORDERS, AND ENFORCEMENT OF ORDERS

§ 231.70 **Inspection of underground and surface conditions; surveying, estimating, and study.**

Operators shall provide means at all reasonable hours, either day or night, for the mining supervisor or his representative to inspect or investigate the underground and surface conditions; to conduct surveys; to estimate the amount of ore or mineral product mined; to study the methods of prospecting, exploration, testing, development, processing, and handling that are followed; to determine the volumes, types, and composition of wastes generated, the adequacy of measures for minimizing the amount of such wastes, and the measures for treatment and disposal of such wastes; and to determine whether the terms and conditions of the permit or lease and the requirements of the exploration or mining plan have been complied with.

§ 231.71 **Issuance of orders.**

Before beginning operations the operator shall inform the mining supervisor in writing of the designation and post office address of the exploration or mining operation, the operator's temporary and permanent post office address, and the name and post office address of the superintendent or other agent who will be in charge of the operations and who will act as the local representative of the operator. The mining supervisor shall also be informed of each change thereafter in the address of the mine office or in the name or address of the local representative.

§ 231.72 **Service of notices, instructions, and orders.**

The operator shall be considered to have received all notices, instructions, and orders that are mailed to or posted at the mine or mine office, or mailed or handed to the superintendent, the mine foreman, the mine clerk, or higher officials connected with the mine, for transmittal to the operator or his local representative.

§ 231.73 **Enforcement of orders.**

(a) If the mining supervisor determines that an operator has failed to comply with the regulations in this part, other applicable departmental regulation, the terms and conditions of the permit or lease, the requirements of an approved exploration or mining plan, or with the mining supervisor's orders or instructions, and such noncompliance does not threaten immediate, serious, or irreparable damage to the environment, the mine or the deposit being mined, or other valuable mineral deposits or other resources, the mining supervisor shall serve a notice of noncompliance upon the operator by delivery in person to him or his agent or by certified or registered mail addressed to the operator at his last known address. Failure of the operator to take action in accordance with the notice of noncompliance shall be grounds for suspension by the mining supervisor of operations.

(b) A notice of noncompliance shall specify in what respects the operator has failed to comply with the provisions of applicable regulations, the terms and conditions of the permit or lease, the requirements of an approved exploration or mining plan or the orders and instructions of the mining supervisor, and shall specify the action which must be taken to correct the noncompliance and the time limits within which such action must be taken.

(c) If in the judgment of the mining supervisor such failure to comply with the regulations, the terms and conditions of the permit or lease, the requirements of approved exploration or mining plans, or with the mining supervisor's orders or instructions threatens immediate, serious, or irreparable damage to the environment, the mine or the deposit being mined, or other valuable mineral deposits or other resources, the mining supervisor is authorized, either in writing or orally with written confirmation, to suspend operations without prior notice.

§ 231.74 **Appeals.**

(a) A party adversely affected by an order of the mining supervisor made pursuant to the provisions of this part shall have a right to appeal to the Director and the further right to appeal to the Board of Land Appeals in the Office of Hearings and Appeals, Office of the Secretary, from an adverse decision of the Director, unless such decision was approved by the Secretary prior to promulgation.

(b) An appeal to the Director may be taken by filing a notice of appeal with the mining supervisor within 30 days from service of the mining supervisor's order. The notice of appeal shall incorporate or be accompanied by such written showing and argument on the facts and laws as the appellant may deem adequate to justify reversal or modification of the order. Within the same 30-day period, the appellant will be permitted to file with the mining supervisor additional statements of reasons and written arguments or briefs.

(c) The mining supervisor shall transmit the appeal and accompanying papers to the Director who will review the record and render such a decision in the case as he deems proper.

(d) Appeals to the Board of Land Appeals shall be made pursuant to procedures outlined in 43 CFR Part, 4, Department Hearings and Appeals Procedures.

(e) Oral argument in any case pending before the Director will be allowed on motion in the discretion of such officer and at a time to be fixed by him.

(f) The procedure for appeals under this part shall be followed for permits and leases on Indian land except that with respect to such permits and leases, the Commissioner of Indian Affairs will exercise the functions vested in the Director. A party adversely affected by a decision of the Commissioner of Indian Affairs under this part shall have a right of appeal to the Board of Land Appeals in the Office of Hearings and Appeals, Office of the Secretary, in accordance with the procedures provided in this section.

(g) With the exception of the time fixed for filing a notice of appeal, the time for filing any document in connection with an appeal may be extended by the officer to whom the appeal is taken. A request for an extension of time must be filed within the time allowed for the filing of the document and must be filed in the same office in which the document in connection with which the extension is requested must be filed.

CROSS REFERENCE: See 43 CFR 23.12 for appeals under 43 CFR Part 23—Surface Exploration, Mining, and Reclamation of Lands. See 25 CFR 177.11 for appeals under 25 CFR Part 177—Surface Exploration, Mining, and Reclamation of Lands.

[FR Doc.72-8267 Filed 5-31-72;8:54 am]

E. Appeals[1/]

§ 3000.0-5 Definitions.

As used in this subchapter:

(a) "Leasable minerals" means oil and gas. (1) Gas means any fluid, either combustible or noncombustible, which is produced in a natural state from the earth and which maintains a gaseous or rarefied state at ordinary temperature and pressure conditions. (2) Oil or crude oil means any liquid hydrocarbon substance which occurs naturally in the earth, including drip gasoline or other natural condensates recovered from gas, without resort to manufacturing process.

(b) "Other leasable minerals" means (1) Coal, chlorides, sulphates, carbonates, borates, silicates, or nitrates of potassium and sodium; sulphur in the States of Louisiana and New Mexico; phosphate; and native asphalt, solid and semisolid bitumen and bituminous rock (including oil impregnated rock or sands from which oil is recoverable only by special treatment after the deposit is mined or quarried). (2) Solid (hardrock) minerals; minerals in acquired lands which would be subject to location under the U. S. mining laws if located in the public domain lands.

(c) "Secretary" means the Secretary of the Interior or any person duly authorized to exercise the powers vested in that officer.

(d) "Director" means the Director of the Bureau of Land Management or any person duly authorized to exercise the powers vested in that officer.

1/ The material in this section appeared in Volume 38 - Number 140 of the Federal Register dated June 23, 1973.

(e) "State Director" means the Director of a Bureau of Land Management State office.

(f) "Authorized Officer" means any person authorized by law or by lawful delegation of authority in the Bureau of Land Management to perform the duties described.

(g) "Proper BLM office" means the Bureau of Land Management office having jurisdiction over the leased lands or lands subject to lease.

(h) "Commercial quantities" means quantities sufficient to provide a return after all variable costs of production have been met.

(i) "Public domain lands" means original public domain lands which have never left Federal ownership; also, lands in Federal ownership which were obtained by the Government in exchange for public lands or for timber on such lands; also original public domain lands which have reverted to Federal ownership through operation of the public land laws.

(j) "Acquired lands" means lands which the United States obtains by deed through purchase or gift, or through condemnation proceedings. They are distinguished from public domain lands in that acquired lands may or may not have been originally owned by the Government. If originally owned by the Government such lands have been disposed of (patented) under the public land laws and thereafter reacquired by the United States.

(k) "Other lands" (1) "Withdrawn lands." Lands which have been withdrawn and dedicated to public purposes. (2) "Reserved lands." Lands which have been withdrawn from disposal and dedicated to a specific public purpose. (3) "Segregated lands." Lands included in a withdrawal, or in an application or entry or in a proper classification which segregates them from operation of the public land laws.

2. Section 3000.4 of Subpart 3000, Chapter II, Title 43 of the Code of Federal Regulations is revised to read as follows:

§ 3000.4 Appeals.

Any party to a case who is adversely affected by any official action or decision of an officer of the Bureau of Land Management or of an Administrative Law Judge, except a decision which has been approved by the Secretary, shall have a right of appeal to the Board of Land Appeals in the Office of Hearings and Appeals, Office of the Secretary. All appeals shall be governed by the rules of practice in Subpart E of Part 4 of this title. Nothing in this group shall be construed to prevent any interested party from seeking judicial review as authorized by law.

VI. ADVERSE EFFECTS WHICH CANNOT BE AVOIDED

Chapter III of this volume detailed the processing options that may be employed to develop the six prototype tracts while Chapter IV considered the adverse effects of development. The present chapter describes for each tract the maximum expected environmental impacts that are both unavoidable and adverse.

A. Colorado Tract C-a

Surface mine development at this tract would have the following unavoidable impacts on the land surface and its existing uses: the soils, the present vegetation, water, air, wildlife, and other conditions.

Land.- Mining of 30 gallons per ton oil shale at a rate of 100,000 barrels per day would require 200 acres for surface facilities, 30 to 85 acres per year for mine development, 140 to 150 acres per year for permanent disposal of processed shale, 1,000 acres for permanent disposal of overburden, and up to 200 acres for temporary storage of low-grade shale. Additional off-site land requirements would include 400 acres for utilities and access roads. The cumulative maximum area affected over a 30-year period, both on and off the tract, would be about 6,650 acres.

The topography of the tract would be altered leaving a different physical configuration than presently exists. If Water Gulch is used for overburden disposal, its topography would be altered (See Chapter IV, Figure IV-5). In addition, a maximum of 5 canyons west of Cathedral Bluffs may be utilized for processed shale

disposal, changing the topography of each canyon so utilized (Chapter IV, Figure IV-3). Soils would be torn up and subsoil and parent overburden material exposed to weathering, increasing erosion. Some subsidence of the land surface would occur over the long term if underground mining were undertaken at Tract C-a.

Traffic.- Traffic levels and size of equipment transported over the road network of the locality of Piceance Creek, Yellow Creek, and the White River Valley would increase and cause some unavoidable impact on existing road beds.

Vegetation.- Vegetative types that would be unavoidably lost or severely damaged by these activities are: (1) pinyon-juniper (1,400 acres), (2) sagebrush (2,260 acres), (3) serviceberry and bitterbrush (2,540 acres), and (4) wildrye and wheatgrass (450 acres). Areas stripped of natural cover would become vulnerable to wind and water erosion until stabilized through revegetation. Since long-term successful reestablishment of effective soil-holding cover is uncertain, some erosion would be unavoidable. Vegetation adjacent to constructed dirt roads and trails would be regularly covered with vehicle-caused dust causing a minor, but notable, loss of wildlife food value.

Recreation and Esthetics.- Waste disposal would unavoidably alter the view of Cathedral Bluffs looking from the Douglas Creek drainage. A private hunting camp located on the tract would eventually need to be removed and hunting in the area would ultimately be reduced. Tract development would penetrate and change the character of the remote and primitive area of the high plateau country between Douglas Creek and Piceance Creek.

Air.- About 2 tons per day of airborne particulates, 8 to 12 tons per day of nitrogen oxides, and 98 to 186 tons per day of sulfur dioxide would result from oil shale processing operations (See Chapter IV, this volume). It is expected that ambient concentrations would not exceed applicable standards. However, under sustained periods of temperature inversion, some unavoidable adverse air quality effects may be experienced in the town of Rangely and Meeker.

Noise.- Noise, including that caused by intermittent blasting on and in the tract vicinity, would increase, causing a disturbance of humans and animals.

Water.- If sufficient amounts of high quality ground water are not available, increasing amounts of surface water will be required, increasing the competition for such water and the effects caused by surface water development, including salt concentration. Over time, ground water produced from mine dewatering may become increasingly saline, which would make treatment and/or disposal necessary. Underground injection, a possible disposal option, would alter ground water movement and could ultimately result in increased discharges of saline ground water to surface supplies. Seismic activity, although unlikely, is a possibility if safe injection pressures are exceeded. Although it is not expected that development at Tract C-a would significantly impact regional water movements, mine dewatering will lower the water table in and around the area of Tract C-a. In which case, up to 37 springs would experience unavoidable adverse effects ranging from reduced flow to cessation of flow, disrupting the natural plant-animal

complex associated with each water feature, including the related distribution of big game, cattle, and wild horses. Unless excess high quality mine water were available to replace the natural flow, the natural plant-animal complex would be unavoidably altered. This loss of water, plus the loss of wildlife habitat, would lower the productive capacity within a several mile radius of Tract C-a which, in turn, would be reflected in lower wildlife and domestic livestock populations.

Wildlife.- On- and off-tract construction and operations would result in the loss of wildlife habitat. Such activities and road traffic, fences, and increased human activities on Tract C-a would result in some rerouting of the traditional mule deer migration pattern around and away from the tract vicinity.

Human activities accompanying construction and operation would, over the life of the lease, have a large net effect on fauna in the tract vicinity due to disturbance. Some species, such as mountain lion, peregrine falcon (endangered), and prairie falcon (likely to become endangered), are intolerant and habitat in the vicinity of the tract would be lost to them. If air traffic occurred on or near the tract, it would constitute an additional disturbance of mule deer, wild horses, and other animals.

There would be some loss of eagles, hawks, and other birds which would come in contact with overhead power distribution lines, if such facilities are installed.

If silt and toxic substances, e.g., contaminated mine drainage and oil, were released to surface waters as a result of either

on- or off-tract construction and operation, exposed vegetation and aquatic habitat would be lost for extended periods of time. Although little aquatic habitat exists on Tract C-a, important resources do exist downstream in trout ponds on Ryan Creek and in the White River. Species which would be affected include trout, suckers, shiners, and associated aquatic organisms and invertebrate fauna.

The most significant wildlife impacts resulting from development of Tract C-a would be the disturbance of behavior and activity patterns of wildlife with accompanying displacement of some species not capable of adapting to a changed environment, a decline in productive capacity with a corresponding reduction in animal populations, and a loss of the primitive qualities existing on and in the vicinity of the tract. Increased hunting pressures would also result in a subsequent reduction in game.

Grazing.- Depending upon the type of mining operation used, there would be an annual loss of 88 to 353 Animal Unit Months (AUM's) of livestock grazing in this area and, in the absence of alternative grazing opportunities, a negative economic impact upon existing operators.

Socio-economic.- Population expansion and economic activity would unavoidably affect the social and economic character of local communities, particularly the town of Rangely, Colorado, and possibly Rifle, Colorado, which could be a railroad distribution point.

B. Colorado Tract C-b

This tract would most likely be developed using underground mining and surface processing as described in Chapter III of this volume. The unavoidable adverse impacts from such development would be as follows:

Land.- The maximum impact would result if all processed shale were disposed of on the surface. This would require approximately 2,000 acres both on and off the tract under the development plan hypothesized in Chapter IV. An additional 200 acres would be required for access roads and utility corridors. The topography of three canyons, the West, Middle, and East Forks of Stewart Gulch, would be unavoidably altered and existing soils and vegetation buried if they are used as disposal areas (See Chapter IV, Figure IV-7). Other soils would be torn up and subsoil material exposed to weathering. Some increased erosion will occur. Also, some subsidence is likely over the long term.

Traffic.- Unavoidable effects similar to Tract C-a would occur in the Piceance Creek locality and the White River Valley or Colorado River Valley.

Vegetation.- Vegetative types that would be unavoidably lost or severely damaged include: (1) pinyon-juniper (475 acres), (2) sagebrush (1,090 acres), (3) serviceberry and bitterbrush (450 acres), and (4) wildrye and wheatgrass (195 acres). Some erosion is unavoidable even after revegetation efforts have been completed.

Recreation and Aesthetics.- The semiremote character of the area south and west of Piceance Creek would be affected by industrial development. Scenic views would be affected by the topographic changes. Hunting in the area would be reduced.

Air.- Residual concentrations of particulates, carbon monoxide, nitrogen oxides, and sulfur oxides would be approximately one-half of those described for development of Tract C-a. Ambient concentrations of these materials would be within applicable standards. Some alfalfa, which is grown along the drainage area of the Piceance Creek, may be unavoidably lost. Some unavoidable adverse air quality effects may be experienced in the Meeker and Rangely vicinity.

Noise.- The general noise level on and in the vicinity of the tract, including that caused by blasting, would increase and be a disturbance to humans and animals.

Water.- Approximately 21 springs would be significantly reduced in flow and 5 wells would experience lowered water tables if the maximum rate of pumping is necessary during development. About 19 other springs and various perennial streams within several miles of the tract would be affected by some reduced flows. Reinjection of excess water pumped from the mine would alter ground water movement and may increase the potential for salt loading to Piceance Creek. Development of surface water supplies, should these be needed, would somewhat increase the salt level of the Colorado River system due to salt concentration and also increase the competition for available surface water supplies. Some minerals and/or organic materials would probably be introduced

into ground water if in situ operations are conducted and could ultimately reach surface waters. The natural plant/animal complex would be unavoidably disrupted as a result of the lowering of water tables, the effects would be about the same as those described for Tract C-a.

Wildlife.- The unavoidable adverse effects on wildlife would include loss of mule deer, elk and golden eagle habitat; increased potential for hunting pressure with subsequent reductions in game populations; some loss of remote primitive qualities; disturbance of wildlife behavior and activity patterns and displacement of some species not capable of adapting to the changed environment such as mountain lion, peregrine falcon (endangered) and prairie falcon (likely to become endangered); a decline in productive capacity with a corresponding reduction in animal populations; a minor loss of birds, particularly hawks and other raptors, through contact with power distribution lines; adverse impacts upon vegetation and animals due to accidential oil losses; and adverse impacts upon aquatic species of the White River due to siltation of and accidental releases of toxic materials into Piceance Creek.

Grazing.- Development at Tract C-b would result in an unavoidable loss of 82 to 139 AUM's of spring/fall cattle grazing.

Cultural Features.- Two Oldland Ranches, the P. L. Ranch, the Redd Cow Camp, and Savage Cabin would be unavoidably affected by increased traffic and noise.

Socio-economic.- The principal unavoidable socio-economic affects associated with the development of Tract C-b would particularly

affect the town of Meeker, Colorado and, possibly, Rifle, Colorado which could become a railroad distribution center.

C. Utah Tracts U-a and U-b

Land.- Development of a 50,000 barrel per day underground mine surface processing system would require some 2,200 acres of land, both on and off the tract area. Such development of Tracts U-a and U-b would cause unavoidable adverse affects similar to those described for Tract C-b. Should Evacuation Creek be used for waste disposal, its topography would be unavoidably altered (See Chapter IV, Figure IV-9).

Traffic.- Traffic levels would increase along the White River Valley road system and roads in tract vicinity causing unavoidable impacts on existing road beds.

Vegetation.- Vegetative types that would be unavoidably destroyed or significantly damaged from such operations include: (1) pinyon-juniper (1,325 acres), (2) saltbrush and greasewood (665 acres), (3) shadscale and winterfat (190 acres), and (4) sagebrush (30 acres). Some erosion is unavoidable prior to and following revegetation as discussed for Tract C-a and C-b.

Recreation and Aesthetics.- Hunting and general recreational use in the area would be unavoidably reduced. An industrial complex would interrupt the scenic view from the White River.

Air.- Residual concentrations of particulates, carbon monoxide, nitrogen oxides, and sulfur oxides would be approximately one-half of those described for development at Tract C-a. Significant impacts on humans, plants, or animals are not expected from

air pollutants released during processing operations, but some decline in air quality is anticipated. Under sustained inversion conditions, some unavoidable effects may be experienced in local communities such as Bonanza, Utah, or Rangely, Colorado.

Noise.- Noise levels would increase causing unavoidable adverse disturbance to animals and those humans associated with the development itself.

Water.- The tract boundaries are close to the White River. If accidental discharges of saline water or toxic materials were to occur and enter this water, such releases would adversely affect water quality and fish; catfish, brown bullheads, and suckers. The endangered Colorado River squawfish and the humpback sucker and boney-tail chub (status undetermined) may also be lost from the White River below its confluence with Evacuation Creek.

Wildlife.- Underground development and processing would destroy habitat for mule deer, chukar partridge, and sage grouse. Golden eagle nesting sites will be adversely affected, and wintering habitat for bald and golden eagles will be eliminated. Animal disturbance (noise, dust, smoke) from construction and operations will be unavoidable. Less tolerant species such as mountain lion, peregrine and prairie falcons will suffer habitat and population losses.

Grazing.- From about 160 to 220 animal unit months of grazing would be unavoidably lost.

Socioeconomic.- Rangely, Colorado and Vernal, Utah would experience population increases and, therefore, unavoidable socio-

economic impacts. The Uintah and Ouray Indian Reservations would be unavoidably affected by development; their recreational and tourist facilities would be used more extensively and employment opportunities created. Cultural differences between the Indians and the more urban oriented populations may result in initial social conflicts.

D. Wyoming Tracts W-a and W-b

Land.- Development of these tracts by in situ techniques would cause the less physical damage to existing surface features than mining and surface processing. However, large truck-mounted drilling rigs and other heavy equipment would impact and disturb much of the natural habitat, since about 4 wells would be required for each acre in the area.

Traffic.- Traffic over the Kinney Rim and along adjacent roads east and west of the Rim would unavoidably increase with noise effects for local residents and some impact on existing road beds.

Vegetation.- Some 7,300 acres of vegetation would be seriously damaged or destroyed, including the following types: (1) black sage (4,480 acres), (2) big sage (1,680 acres), (3) shadscale (1,050 acres), and (4) saltgrass (60 acres).

Recreation and Aesthetics.- Hunting opportunity in the tract areas would unavoidably decline and hunting pressure in adjacent areas increase. Kinney Rim, now an accessible scenic feature, could become difficult to visit if development closed

the Kinney Rim road. Industrial development will penetrate the primitive character of the area.

Air.- The residual pollutants from in situ processing will unavoidably lower air quality somewhat, but are expected to be somewhat less than those associated with either underground or surface mine development followed by surface processing. Significant unavoidable affects are not likely. Dust will be a local problem due to the movement of heavy truck mounted drilling equipment.

Noise.- Explosions associated with the fracturing of the formation prior to in situ processing will be introduced into the locality but should not be widely notable except in the immediate area of the tract. However, noise levels will increase over ambient levels due to the movement of equipment, causing a disturbance of humans and animals.

Water.- Ground water at this location is believed to be limited in volume, but organic materials formed during underground retorting could escape into the aquifers if pressure conditions were unfavorable. In this event, springs on the east slope of the Kinney Rim would be adversely affected. Transfer of some heat from thermal in situ processing to local ground water is unavoidable; the effects are uncertain.

Wildlife.- Antelope, mule deer, and sage grouse habitat will be severely damaged or destroyed. Nesting habitat for the endangered peregrine falcon in the vicinity of the tracts will be adversely affected.

Disturbance factors from construction and operation will be unavoidable, and will adversely affect wildlife, with less tolerant species such as the mountain lion and various raptors suffering both on- and off-tract habitat loss. In the unlikely event that toxic substances were to reach Vermillion Creek and the Green River, some aquatic organisms and their habitats would be lost, including suckers and trout.

Grazing.- An average annual grazing loss of about 170 AUM's is expected in the combined areas.

Socioeconomic.- Population expansion and economic activity will impact most heavily upon Rock Springs causing some unavoidable adverse effects.

VII. Irreversible and Irretrievable Commitment of Resources

Certain inescapable commitments of resources associated with development will be involved in the leasing of six (6) selected tracts as considered in this proposal. The following discussion identifies those significant commitments for the general environments of the 6 tract localities involved.

Land

Between 10,000 and 13,000 acres of land would be required for mine and plant facility construction, processed shale disposal sites, utility corridors, and access roads. The surface area commitments of major significance would be waste piles, overburden areas, regraded areas, topsoil borrow areas, any areas buried by wastes or storage piles (such as the canyons), and those places where heavy construction emplacements become established, e.g., permanent road beds, plant foundation sites, and water impoundment areas. Commitments of many of the impoundment areas would not be wholly irretrievable, but depositional materials could have an irreversible effect since they might not be able to support the original plant cover existing on the site.

The topographical changes caused by development, particularly for waste storage and overburden removal, will involve both irreversible changes and irretrievable commitments of the overburden soil and rock materials and the shale waste minerals. They will undoubtedly remain in their new form and location until acted upon

by natural earth-forming processes over geologic time. The quantities, condition and character of these changes have been set forth in detail in earlier sections of this volume. Any topsoil which is moved will irreversibly alter the area from which it is taken as well as the soil itself. The soil horizons will be destroyed and soil weathering will have to begin anew upon the residual soil areas left. Soil structure, soil organisms, and humus content will probably be lost. The supplies of topsoil that become either buried through overburden removal, product storage, canyon filling or lost through construction activities and erosion are essentially irretrievable commitments of existing topsoil. They will be removed from use and unavailable for any future use. These topsoil removal areas vary from site to site and between different operations on each site. The land character now existing in the 6 different localities insofar as slope, drainage system, elevation, aspect, ruggedness, and contour will be irretrievably altered to something new, different and more indicative of man's presence and use.

Minerals

All minerals removed in the process of mining and shale oil processing, including related ancillary mineral development, will be both irreversibly removed from the sites and irretrievably committed to economic utilization. This would include some 3-to-5 billion barrels of shale oil and possibly nahcolite, dawsonite and halite minerals.

Vegetation

The existing grass/shrub/tree interrelationship and the vegetation itself will be irretrievably destroyed, but it is uncertain if this constitutes an irreversible action. Revegetation will be required under the terms of the lease, but, as discussed in Chapter IV, Section A.5, the reliability of establishing and maintaining an effective plant cover over the long-term and the pattern of successional changes is uncertain. While some vegetative cover is ultimately assured, introduced species may be susceptible to setback by climatic conditions and attack by insects and diseases.

Grazing

All forage production foregone by existing operators upon the 6 tract areas and related economic effects represent irretrievable losses to both operators and the public as the result of foregone revenues.

Faunal Resources

Irreversible effects on fish and wildlife resources would include losses of faunal habitat on and near the tracts (possibly reversible), at associated urban development areas, and a net loss of semiwilderness and undisturbed faunal values associated with the tracts. Animals destroyed and wildlife production foregone on and near the tracts during the life of industrial development represent irretrievable resource commitments.

The most significant changes would be those affecting intolerant species of wildlife such as mountain lion, elk, falcon, eagles,

and any endangered species that may inhabit or use the areas affected by development. These species cannot be maintained under the altered environment. Other species, such as small game, reptiles, some birds and some larger game, i.e., mule deer, following eventual abandonment of the areas affected by development, will probably repopulate these areas if they are restored and revegetated with wildlife food and cover species.

Most fish populations would not be irreversibly lost by development. If a single massive water pollution accident were to occur, however, the endangered Colorado River squawfish, the humpback sucker, and/or boney-tail chub (status undetermined) may be irreversibly lost. If impoundments are constructed in areas which serve as spawning habitat for these species, irreversible losses would result.

Recreation Resources

Hunting opportunities precluded on and near the tracts during, and for some time after, oil shale development would be irretrievably lost. These losses, however, would not be irreversible since upon the abandonment of mining and upon revegetation of the land with wildlife food and cover species, hunting opportunities could be reestablished. (The scope of recreational use for each tract is discussed in Chapter IV, Section F).

Water Resources

Technically, water is not irretrievably consumed since it is ultimately returned to some part of the earth's hydrologic cycle. Practically, however, water consumed for oil shale development will

foreclose other uses of the water. Therefore, the amount used will be irretrievably inaccessible for other uses, e.g., irrigation. Waters damaged in quality by the introduction of toxics, salinity, increase loading with nutrients, decreased dissolved oxygen and increased temperature are in a technical sense neither irreversible nor irretrievable. However, such changes may cause regional effects that remove such water from a particular use at a particular location for a period of time. The variety of potential effects is great in the oil shale region. During such periods and at any location where the effects are experienced, the uses which are foregone because of water quality reduction suffer irretrievable losses, e.g., fish killed or driven away because of temperature and oxygen changes. Most of these conditions are reversible by technical means or by cessation of the act causing the pollution. However, environmental costs thus passed on to wildlife, fish or even human users (for drinking or agricultural purposes, for example) do represent irretrievable secondary costs which could extend beyond the period of active resource development. Practical utilization of ground water resources is more confined than that of surface waters due to fewer direct uses of such waters. However, should pollutants enter the relatively confined ground water systems, the effects may be irreversible over long periods of time. Therefore, such contaminated water itself may be retrievable, but would be unusable (See Chapter IV, Section B of this volume). Revegetation

and erosion control measures will be designed in so far as possible to minimize long-term maintenance and produce vegetation capable of holding the soil and surviving under natural conditions. Weathering and leaching of the shale piles will nevertheless occur over long periods of time. Unless maintained, diversion structures and ponds will silt up and head cutting and gullying will accelerate erosion from the piles. The net impact on the regions water resources due to such long-term forces is uncertain; sediment and minerals are currently being released to local waters and over the short term (decades), the spent shale piles may contribute somewhat lower salt/sediment loads than are now being contributed. However, over the longer term (several decades), the effects will probably increase progressively, adding such materials cumulatively to the Colorado River system. The net change from a possible short-term benefit to a longer interval of time in which conditions are similar, or perhaps worse than that now existing, cannot now be quantified.

Air Quality Resource

Any degradation of the air quality in the oil shale region, as anywhere else, is retrievable from a technical standpoint. For all practical purposes, the reduced air quality resulting from long-term industrial development is essentially irreversible for the localities affected (See Chapter IV, Section C for the scope of air quality effects associated with each tract development.).

Cultural Features

Roads, structures, impoundments, wells and other works of man that may be destroyed or rendered useless during the course of development are both irreversibly and irretrievably lost. They are, however, replaceable. (The kinds and numbers of cultural features associated with each tract are specifically identified and idscussed in Chapter IV, Section A).

Archeological and Historical Resources

The existence of archeological and historical resources directly associated with the 6 tracts is uncertain. If any do exist, accidental damage would represent an irreversible alteration to the resources themselves and accidental destruction would be an irretrievable loss.

Economic Resources

Economic benefits possibly foregone as the result of oil shale development, such as private grazing, irrigated agriculture, and public revenues, will be irretrievably lost, but would be reversible upon termination of operations. Although economic resources committed in oil shale development are retrievable in the sense that profits could be made, the opportunity to invest such resources in an alternative way is irretrievably foregone.

Royalties and income, property, and sales taxes to governments would be stimulated by oil shale development and can be considered irreversible over the development period. Management of the proposed prototype program would involve a continuing but reversible investment

of Federal resources which is not irretrievable, since Government receipts (about $135 million per year) would exceed estimated management cost of less than $1 million per year (See Chapter IV, Section G).

Social Resources

The effects of oil shale development on existing cultural habits and mores and such social conditions as equilibrium and tranquility in the communities and countryside associated with the tracts are, for all practical purposes, irreversible since social changes set in motion by large-scale industrial development seldom return to their original state. The towns and communities that would be affected by development of the 6 tracts are discussed in Chapter IV, Section G.

Transportation System Resources

Changes and expansion in the transportation network as the result of oil shale development are likely to be sufficiently permanent as to be considered virtually irreversible. Some change of this nature would be associated with each tract.

Sound Resources

The rural quietude of the existing communities in the areas will be irretrievable during the period of development and operations. It will be similarly irretrievable for wildlife habitat areas disrupted.

As roadways and communites expand, the change and commitment to generally higher levels of sound would be practically irreversible.

VIII. RELATIONSHIP BETWEEN LOCAL SHORT-TERM USES OF MAN'S ENVIRONMENT AND THE MAINTENANCE AND ENHANCEMENT OF LONG-TERM PRODUCTIVITY

The analysis of the relationship between local short-term uses of man's environment and long-term productivity of the oil shale region was discussed in Chapter VI of Volume I. That analysis dealt with the long-term environmental productivity of the various resources and values on a regional basis. It was shown that the character of the industrialization of the regions will be similar to that commonly associated with the mining industry. These industrialization changes will intensify the utilization of the region's air, water, land, vegetation, mineral, fish and wildlife resources, outdoor recreation, and its primitive, archeological, historical and esthetic values. It was discussed that the original condition of the land and the mineral resources will not be renewable as all of the region's resources become increasingly used by an expanding population. The productivity of the various resources and values will react differently, both in timing and degree, to the short-term uses made of them by oil shale development. None will be particularly enhanced except for mineral production and economic development. Long-term productivity in most cases will be maintained but in a declining trend.

The local short-term uses and environmental resources and values discussed in Volume I, Chapter VI for the region are the same for the six tracts which are the subject of the specific proposed action. Thus what was said in that Chapter concerning the relationship

between those uses and the long-term productivity of those resources and values applies here as well, although on a proportionally smaller scale. The reader is referred to Volume I, Chapter VI, for the analysis of that relationship.

IX. ALTERNATIVES TO THE PROPOSED PROGRAM

A. Program as Proposed

Chapter I of this volume has detailed the proposed action, which is to make available for private development, under lease, a limited amount of the public oil shale resources. Such leases would be sold by competitive bonus bidding subject to rental and royalty obligations to the United States. The lease under which development would proceed is presented in Chapter V of this volume. Contained also in that chapter are the special stipulations designed to mitigate environmental damage.

The proposed action is designed to lead to commercial oil shale development by private industry and to provide an opportunity to test four development options. If implemented successfully, the most likely pattern of development is expected to be as shown in Table IX-1.

Prototype development would not be expected to occur on each of the tracts at the same time, and, as discussed in Volume I, Chapter III, Section A, the underground development in Colorado is estimated to reach its expected level of production in 1978, the surface mine development in 1979, the underground developments in Utah in 1980, and the Wyoming in situ production in 1981.

TABLE IX-1.--Likely Pattern of Prototype Development.

Tract	Expected Production, barrels per day — Likely Method of Resource Development: Surface Mine	Underground Mine: Type I[1/]	Underground Mine: Type II[2/]	In Situ
Colorado C-a	100,000			
Colorado C-b		50,000		
Utah U-a and U-b			50,000[3/]	
Wyoming W-a and W-b				50,000[3/]

1/ Type I involves development of the Mahagony Zone and the lower oil shale zone in an area that would probably require dewatering prior to and during operations.

2/ Type II - Lower oil shale zone absent and mining would be confined in Mahagony Zone. Large amounts of water are not expected to be encountered.

3/ Combined production from two tracts.

Total production from the combined six tracts is not expected to exceed 250,000 barrels of shale oil per day. The description of each tract referenced above is contained in Chapter II of this volume; the most likely plan of development is presented in Chapter III. As indicated therein, Tract C-a would most likely be developed as a surface mine, C-b as an underground mine in an area that will require mine dewatering prior to and during development, U-a and U-b as underground mines in an area likely to contain only small amounts of water, and W-a and W-b as in situ operations. The impacts on the environment arising from the most likely manner of development and the feasible development alternatives for these six prototype tracts are documented in Chapter IV.

B. Government Corporation

An alternative means of attaining the commercial-scale operation envisioned in the proposed prototype program is direct government development. As suggested by recent bills introduced in Congress (1, 2), this alternative could take the form of a corporation managed by a board of directors appointed by the President of the United States.

The function of the corporation (2, p. 29) would be to select two or more methods for producing shale oil and demonstrate the technical, environmental, and economic feasibility of each method selected. Following successful demonstration,

the corporation may then design, construct, operate, and maintain a full-scale, commercial-size facility to produce shale oil for each method.

Existing government corporations, such as the Postal Service, AMTRAK, or COMSAT, have been formed to provide services on a regional or national scale under circumstances where private enterprise lacks the incentive or capital to make the necessary investments. However, the product of the proposed prototype development, shale oil, is not a service. It is an intermediate product identical to that already provided by private industry from other domestic sources and through oil imports. Therefore, shale oil would directly compete for existing markets.

Such a corporation, engaged in a single risk operation, would have a higher cost of capital than would a private corporation with diversified operations. Government underwriting of the risk would probably be required and is envisaged in the proposed legislation (1, p.15, 2, p.30).

In sum, a Government corporation, while an alternative to the proposed prototype leasing program, would under the concepts advanced to date (1, 2), assign the primary responsibility for economic development of oil shale to the Federal Government, and would potentially place it in competition with private industry for the sale of fuels and associated materials.

Environmental Impacts

To attain the level of production forecast for the proposed prototype program (250,000 barrels per day) a Government corporation would require mining, crushing, and processing about 300,000 tons per year of 30-gallon per ton oil shale. Between 8,000 and 11,000 acres of land surface, both on-site and off-site, would be required for the construction of mines, plant facilities, and processed shale disposal. In addition, some 1,700 to 2,000 acres would be altered due to the construction of utility corridors and access roads.

Between 4 and 13 typical canyons (see Chapter IV, Section A), would probably be used for disposal of the spent shale, which would permanently alter the topography of these canyons and destroy the existing vegetation (see Chapter IV, Section A).

Excess water may be encountered in Colorado oil shale mines and a means of disposal would be required. Developments in Utah or Wyoming are expected to be essentially free of water. The impacts on supply and quality would therefore be similar to those described in Chapter IV, Section B).

The total quantities of pollutants emitted to the atmosphere would probably be as follows: particulates 4 to 25 tons per day; nitrogen oxides 20 to 38 tons per day; and sulfur oxides 15 to 500 tons per day. Ambient air quality standards would probable be achieved for each individual plant, but pollutants trapped under persistent inversion conditions may cause cumulative adverse effects in localized areas.

Thus, since the scale of operations and land area used by the Corporation would be about the same as under the proposed prototype program, and assuming a similar development schedule, the impact on wildlife, vegetation, grazing, recreation, cultural, archeological and historical features, and minerals would be similar to that described in Chapter IV of this volume.

It is difficult to foresee how significant environmental differences would arise between development by private industry or development under the auspices of government corporation. It may be argued that unlimited funds could be made available to be used to reduce environmental impact to support a government corporation. On the other hand, it can be argued that it would be easier for private industry to raise required funds than for a government corporation to obtain continued appropriations. In either case, however, the possibility exists that fiscal constraints might result in environmental control being one of the items subject to reduced investments. It should be noted, however, that under the program as proposed, private enterprise may be able to recover "extraordinary costs" for environmental control. The key consideration is the efficacy of the environmental control systems themselves. Regardless of the organizational structure, about the same amount of oil shale will need to be processed to reach a 250,000 barrel-per-day level of production. The organizational form required to attain this level of production would not sufficiently influence technological

factors or systems design to allow a conclusion that significant environmental differences would occur due to that distinction. Thus, any commercial development by a government corporation would be expected to cause environmental impacts similar in magnitude and scope of those described elsewhere in this volume.

C. Government or Government/Industry Demonstration

A demonstration of technology by the Government is a feasible means often used when there are a number of competing technologies, none of which have been proved to be commercially viable, and it is in the national interest to accelerate technologic development. Such a demonstration, while capable of establishing certain economic and environmental parameters as discussed below, will not achieve a major objective of the proposed prototype program to stimulate commercial-scale production and technology.

The manner of organization can take many forms, but generally involves: (1) demonstration by the Government itself, or (2) a government/industry demonstration. The former has often been used by the government. For example, under the Synthetic Liquid Fuels Act of 1944 (3), an oil shale demonstration facility near Rifle, Colorado, was established. During the period 1944-56, the Bureau of Mines developed and demonstrated the gas-combustion retort in two small pilot plants (nominal capacities 6 and 24 tons/day.) The program was terminated before operability of the largest of the three pilot plants had been demonstrated (originally rated at a

capacity of 150 tons/day.) From 1964 to 1968, this retort was tested and significant process improvements were achieved under a lease agreement with the Colorado School of Mines Research Foundation who had a subsequent research contract with six oil companies (see discussion, Volume I, Chapter I, Section C.1.c.) Currently, the Rifle facility is under lease to the firm of Development Engineering Incorporated of Denver, Colorado, for the purpose of conducting retorting-waste management research (4). In addition, the Department of the Interior, through its Synthane Demonstration Project, is conducting a demonstration of a process to convert coal to substitute natural gas which is being supported totally with public funds.

A second option under this alternative program is a government/industry demonstration, where development costs are shared. A current example of this course of action is coal gasification. The Department of the Interior, through the Office of Coal Research, and industry, through the American Gas Association, have entered into a joint cost-sharing agreement to promote the technologic development of three different processes to convert coal to substitute natural gas.

As indicated above, the Bureau of Mines gas-combustion retorting process has been demonstrated beyond the 150 ton-per-day level, while that developed by the Union Oil Company reached 1,000 tons-per-day during 1956 to 1958. A 1,000-ton-per-day level of throughout was also achieved by the Colony Development Operation in experiments that ended in 1972. Another oil shale project has reached the large

scale demonstration phase in Brazil. This modern complex is capable of processing oil shale at a rate of 2,500 tons per day. The technology is similar to that developed in the United States by the Bureau of Mines.

At this point in time, a demonstration should be of sufficient mining, retorting, and upgrading scale to permit more reliable estimates of costs, to set the stage for demonstration of commercial-scale technology, and to estimate more accurately the potential environmental impacts of a mature oil shale development. Scale-up beyond present capabilities to the 10,000 tons per day level of operation would enable these objectives to be reached.

Among the factors to be considered in implementing this alternative are time and the amount of adequacy of information that would be obtained.

In all probability, it would require from 3 to 5 years before construction could begin. This time is required to plan the scope of the activities, obtain Congressional approval and funding, and to prepare detailed engineering designs of the plant(s), and supporting facilities. Some two years would be required to construct the demonstration plant(s) and to develop the mine(s) before operations could begin. Thus, it would take from 5 to 7 years to plan, design, and construct the 10,000 barrel per day demonstration plants. From 2 to 5 years of operation would be required to prove out the technology and establish information concerning environmental impacts,

Through experience, more reliable information would be developed on the operability of the equipment and costs as the demonstration

program progressed. During the two years required for construction, the impact of such activities on the local environment would be delineated, and the impact on the socioeconomic structure could be more accurately estimated.

The organizational form and development pattern of a demonstration program are unknown. However, as an alternative to the program as proposed, it may consist of: (1) an underground mine development in Colorado at a location where water would need to be pumped; (2) underground mine development in Utah to establish the feasibility of development in the Uinta Basin; and (3) an expanded program of in situ research in Wyoming. Surface mine development would not likely be employed because the long period required to reach the oil shale (over 20 years at the 10,000-ton-per-day rate of extraction) would negate the objectives of a short-term demonstration.

In sum, a demonstration of underground mining and surface processing and in situ processing could establish the feasibility and costs of operating large scale equipment under various geologic conditions. However, at the end of the demonstration(s), from 7 to 12 years, this alternative would not achieve a major objective of the proposed program which is to stimulate the development of commercial oil shale production and technology by private industry. Additionally, as discussed below, a demonstration(s) is not sufficient to obtain information on a scale large enough to allow informed decision-making concerning the cumulative regional effects of long-term, full-scale commercial development. A demonstration program will not therefore achieve the same objectives of the program as proposed.

Environmental Impacts

A 10,000-ton-per-day (7,000 barrel per day of shale oil) demonstration plant would produce some environmental impacts that are directly proportional to a commercial size operation[1/] and some impacts that are not directly proportional. This is due to reductions in efficiency when smaller units are used for industrial operations, i.e., the opportunity to realize economy-of-scale is precluded.

Examples of direct proportionality are the amount of oil shale to be mined and processed, the quantity of shale oil produced, water requirements, the amount of spent shale to be disposed of, and the amounts and types of air pollutants. These would be about one-seventh of the values presented in Chapter III for a plant that produces 50,000 barrels per day if the demonstration plant was scaled to the 10,000-tons-per-day level of operation (or 7,000 barrels per day). However, proportional reductions in the number of people required would not occur since, for either plant size, it will require about the same number of administration personnel. Additionally, the plant size would not be reduced by a factor of one-seventh; a reduction of about one-half is a more realistic estimate. Moreover, as a new technology matures, the real costs of production can be expected to decrease. This is known as the

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1/ A 50,000-barrel-per-day underground mine development or a 100,000-barrel-per-day surface mine development. It is assumed that current in situ research could be expanded, but, as discussed in Volume I, Chapter I, Section C.2, scale-up to a larger scale operation would probably not be feasible in the near future.

"learning curve effect" (5). A recent assessment of this effect, as it relates to oil shale (6), indicates that a 10 to 15 percent reduction in costs can be realized for each doubling of industry capacity. Conversely, at the 10,000-ton-per-day level, the capital investment and operating costs per barrel will be higher.

The key parameters involved in comparing environmental impacts are those shown in Table IX- 2 for a demonstration plant as compared to a 50,000 barrel per day commercial operation. As indicated therein, the area needed for utility corridors and access roads would probably be no different for either a demonstration or a commercial plant. The impact on the environment due to commercial-scale construction of utility corridors and access roads could therefore be predicted with a high degree of accuracy in either case. However, this impact is of short duration and relatively minor when compared with the longer-term cumulative impacts caused by development.

Approximately 0.18 million cubic feet per day of processed spent shale would need to be disposed of as compared to 1.3 million cubic feet per day from the commercial sized development. If this waste material is placed into a typical canyon (Figure IX-1), the amount of surface area exposed will change with time. The relationship between the depth of the spent shale, surface area exposed, and time is shown in Figure IX-2.

Since a cross section of the canyon used in the hypothetical example above approximates a triangle, the depth rate at which the

TABLE IX-2.--Environmental Comparison Demonstration vs. Commercial.

	Demonstration Plant 7,000 barrels/day	Commercial Plant, 50,000 barrels/day
Land Requirements, acres		
Facilities	70	140
Utility Corridors/Access	200 to 600	200 to 600
Processed shale, million cubic yards per year	2.6	19.3
Water required, acre-feet/year	1,000 to 1,500	6,800 to 10,600
Emissions, tons per day		
Airborne dust	0.1	1.0
Sulfur dioxide	6.6 to 12.6	49.0 to 93.0
Nitrogen dioxide	0.6 to 0.8	4.0 to 6.0
Personnel		
Construction	750 1/	1,500 1/
Operating	475 to 650	950 to 1,300

1/ Maximum number.

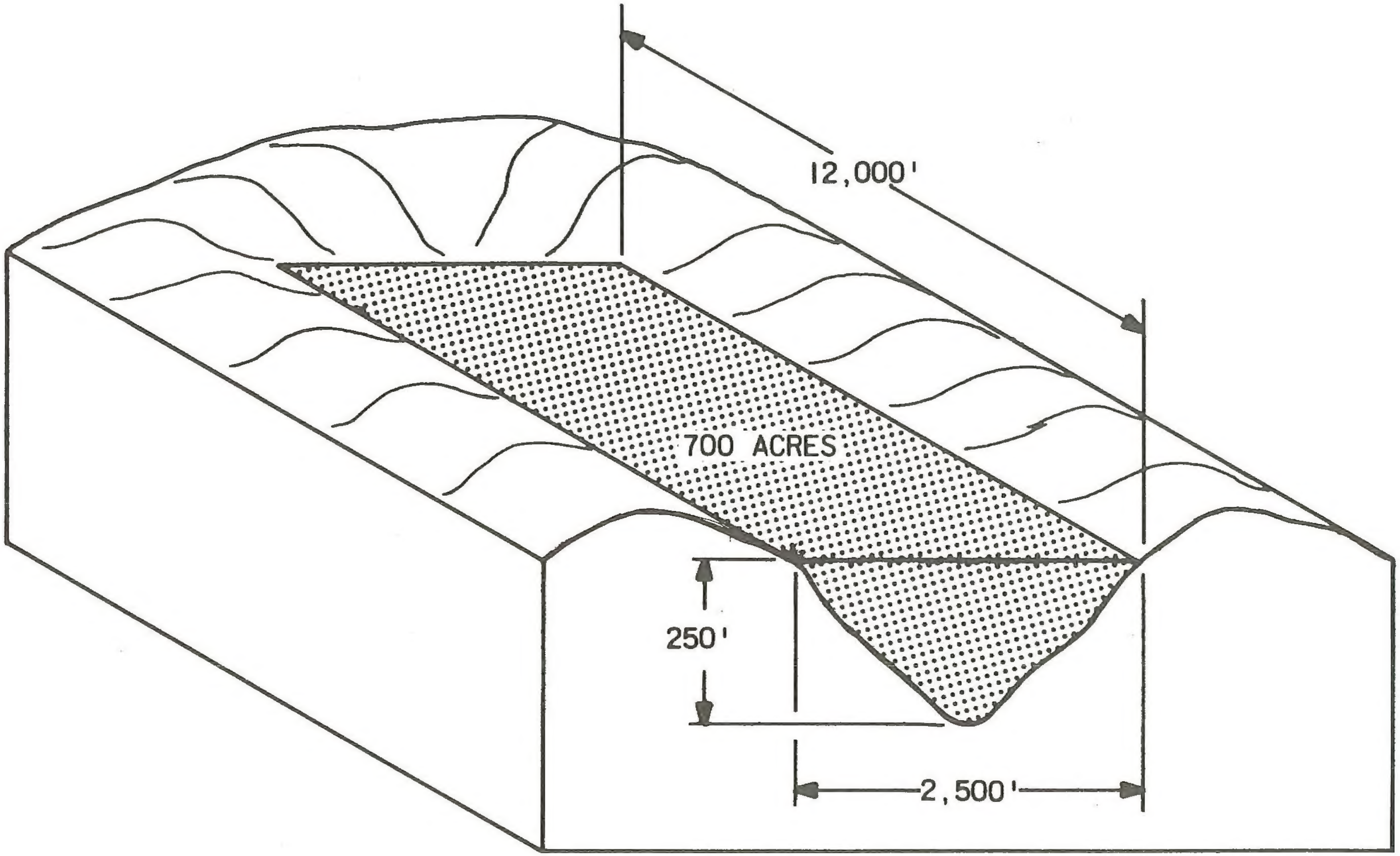

FIGURE IX-1.--Hypothetical diagram of a canyon for spent shale Disposal.

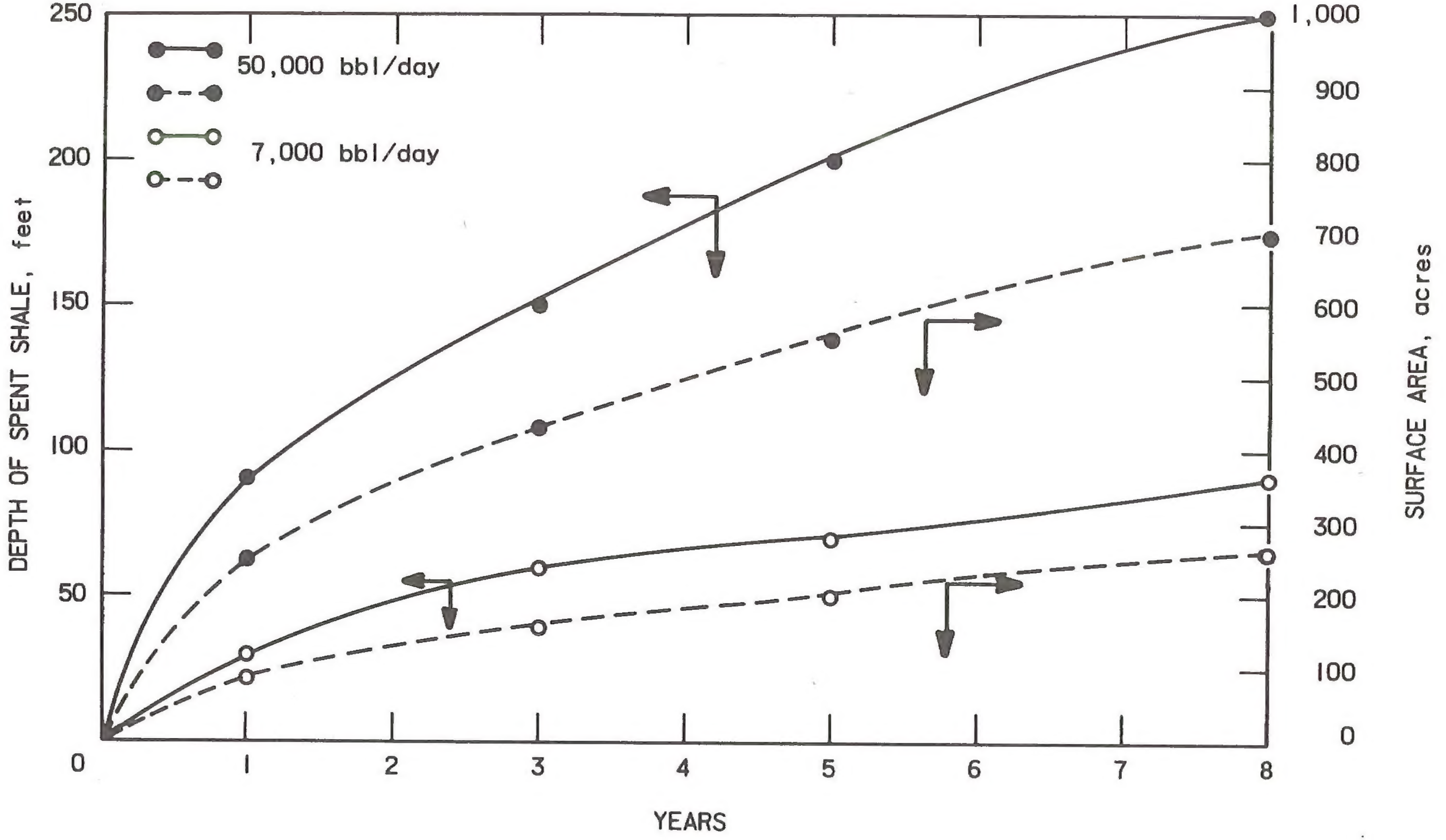

FIGURE IX-2.--Typical canyon buildup relationship for a 50,000 and 7,000 barrel per day oil shale operation.

canyon is filled will decrease with time. For example, for a 50,000 barrel/day oil shale operation (74,000 tons per day of oil shale processed) the time, depth, and surface area relationship will be as follows:

Time, years..................	1	3	5	8
Depth of spent shale, feet...	90	150	200	250
Surface area, acres..........	250	430	550	700

At the end of 8 years the depth of spent shale will be 250 feet and the surface area exposed will approximate 700 acres.

For a 7,000 barrel/day demonstration plant (10,000 tons per day of oil shale processed) 8,000 tons per day of spent shale will require disposal. Since the volume of spent shale is less, the typical canyon will not be filled to as great a depth. The time, depth, and surface area affected would therefore be as follows:

Time, years..................	1	3	5	8
Depth of spent shale, feet...	30	60	70	90
Surface area, acres..........	90	160	200	260

At the end of 8 years, the depth of spent shale will be 90 feet and the surface area exposed will approximate 260 acres.

The data above indicate that sufficient material would be produced from the demonstration to study revegetation under typical large scale commercial conditions. However, the amount of material would not be sufficient to attain a full range of information on the characteristics of pile stability, including cementation and resistance to failure, leaching, and erosion on the commercial scale level. For example, the wastes produced from one demonstration plant would not

adequately represent the range in particle size and chemical characteristics that would occur with commercial development. The three commercially possible retorting processes cannot be utilized effectively and commercially in one demonstration plant. In addition, commercial development would create large waste piles having a depth of 250 feet or more. Except over very long periods, a demonstration plant cannot produce enough material to permit study of the effects of pressure created by the height and the possibility of pile failure.

The air emissions (Table IX-2) are estimated to be one-seventh that of a commercial plant. Ambient air quality standards are believed to be attainable with a commercial plant, but pollutants trapped under inversion conditions may cause cumulative local adverse effects on vegetation. Impacts of the same magnitude would probable not be caused by the smaller demonstration plant due to the relatively small amount of material emitted on a daily basis.

If the demonstration mine were located in the Piceance Creek Basin (for example, at Site C-b) the mine would probably be dewatered prior to development of the Mahogany Zone. The impacts of such dewatering on local springs, wells, and streams could be measured. However, due to the relatively small scale of mining needed, development of the lower oil shale zone would probably not be attempted. Thus, both the upper and lower water-bearing formations probably would not be pumped and the maximum expected pumping rate of 40 cfs would not be attained. Additionally, dewatering of a surface mine development would not be investigated since the time required to reach the deposit (discussed previously) would preclude a demonstration surface mine. Thus, the full impact of mine dewatering on a commercial scale would

not be determined. Furthermore, with limited shale oil production, the full range of potential cumulative impacts on regional water quality which might result from mature industrial development (discussed in Volume I, Chapter II, Section B) could not be assessed nor would methods of control be developed.

D. No Development/Delay Development on Public Lands

As an alternative to the program as proposed, the Government could delay implementing the program indefinitely. The purpose of this delay would be to obtain further information concerning ways to mitigate the environmental impacts of oil shale development and/or to search for new locations that may have fewer environmental impacts.

Of particular relevance is the possibility of delaying the program until the joint government/industry environmental studies now being conducted in Colorado, are completed. These studies are aimed at four areas: (1) revegetation and surface rehabilitation; (2) environmental inventory and impact; (3) water resource management; and (4) regional development and land use planning. Though the studies are being conducted specifically for Colorado's Piceance Creek Basin, much of the information developed will be applicable to development in Utah and Wyoming.

It is expected that these studies, in which the Department of the Interior is an active participant, will provide additional information which will assist in efforts to mitigate environmental

damage. The timing of these studies and development under the program as proposed are the key factors that must be considered in assessing this alternative.

Each of the four Colorado studies is scheduled for completion before 1975. Oil shale development on public lands under the proposed program could not begin before detailed development plans have been prepared and publicly reviewed. These would not be available until about 1976. Thus, the results of the Colorado studies would be available for each lessee to incorporate into his detailed plans for development prior to physical development of the resource itself. In addition, under the program as proposed, each lessee will be required to establish two full years of additional baseline data on air and water quality, wildlife populations and movements, and more detailed descriptions of the vegetative cover. These data would also be incorporated into the detailed plan for development, and the plan would be subjected to public review and possible modification. Thus, the ongoing studies in Colorado, which are regional in nature, and the activities that would be conducted under the proposed program, which are site specific, are complementary. Each can proceed at the same time and, in so doing, provide cumulative environmental information of both a local and regional nature that will be available for use in designing the detailed plans for tract development.

A second reason for delay may be to search for locations that would achieve the objectives of the program as proposed, but could be developed with fewer environmental impacts. It is conceivable that such locations could be found since many locations represent a potential for an underground mine or in situ development. Alternative potential locations for surface mine developments also exist (7, 8, 9, 10). These alternative locations on public land can be translated into several thousand individual tracts of 5,000 acres each. To review the potential environmental impacts at each site in the same detail as that presented in this final statement would take many years (perhaps 10 to 20), and a large commitment of human and financial resources. However, without firm data based on physical development of the resource, the distinctions that would make one tract environmentally better than another would remain very difficult to assess.

A program delay, whether for time to assess the environmental impacts of other locations or to obtain further information on the environmental impacts of the proposed program, will not resolve the environmental issues that can only be answered by development itself. A methodical survey of all the public lands may or may not reveal tracts where the program objectives could be achieved with lesser environmental impact. The survey would also delay the development of concurrent information concerning the environmental impact of physical development on public lands. In either case,

a judgment is required to evaluate how best to obtain adequate amounts of timely environmental information.

Environmental Impact

No development or delaying development would avoid altogether or postpone indefinitely, respectively, any environmental impact of development on public lands. However, it is likely that the information that would be gained during the delay would be of limited value in mitigating the actual impacts of any eventual development. Physical development is required to provide the data needed to assess the actual impacts of development, particularly as they relate to ground water management. Without such data, the analyses will continue to remain hypothetical extensions of laboratory studies or comparison to similar industrial development.

E. Private Development on Private Lands

As an alternative to the program as proposed, the Government could take no action with the expectation that private industry would develop private lands. The objective of this course of action would be to prove that oil shale development is economically sound and environmentally acceptable prior to development on public lands. Three key parameters must be considered in evaluating this as an alternative to the proposed program: (1) the adequacy of the resource on private lands, (2) the willingness of the owners to develop their properties, and (3) the adequacy of the environmental information that could be developed. Each of these parameters are examined below.

The ownership pattern of oil shale lands controlled by major oil companies is given in Table IX- 3 . That listing indicates that some 235,000 acres of oil shale lands are potentially available for development, with the majority of interest centered in Colorado's Piceance Creek Basin. Although a few firms have rather large cumulative holdings, it should be noted that a single large ownership of land does not necessarily constitute a viable economic unit because the tracts that comprise the total acreage shown in Table IX- 3 are not contiguous. However, at least three (probably no more than 5) oil shale tracts in private ownership contain enough oil shale to support commercial scale operations. Thus, private development is possible on private lands.

The capability or willingness of the current owners of suitable private lands to develop these tracts alone or as a joint venture with other firms cannot be directly assessed at the present time. A number of factors will need to be assessed by such firms, such as the economic viability of shale oil production as it relates to specific supply requirements.

As outlined in Volume I, Chapter III, Section A, the total capital required for a single commercial complex of 50,000 barrels per day would approximate $250 million. The return on this investment is only marginally attractive at 10 to 13 percent on a discounted cash flow basis. Low-profit expectations has been a fundamental reason why oil shale has not been commercially developed to date. Future expectations concerning production costs, oil prices, the general state of the economy, and the availability of

TABLE IX-3. Consolidated Holdings, Major Oil Companies

	Oil Shale Ownership 1/						Ranking Oil Companies	
	Colorado		Utah		Total		By Assets 2/	By Sales 3/
	Net Acres	Tracts 4/	Net Acres	Tracts 4/	Net Acres	Tracts 4/		
Standard Oil of California	40,950	4	0	0	40,950	4	5	12
Union Oil	29,630	3	0	0	29,630	3	14	50
Texaco	19,170	3	8,300	1	27,470	4	2	9
Getty (Tidewater)	24,300	1	0	0	24,300	1	16	91
Atlantic Richfield	19,730	13	2,570	1	22,300	13	7	22
Mobil	19,280	2	0	0	19,280	2	4	6
Sohio (Standard, Ohio)	9,620	12	8,970	5	18,590	17	17	86
Exxon	10,550	29	0	0	10,550	29	1	2
Continental Oil	10,240	1	0	0	10,240	1	11	23
Cities Service	9,000	1	0	0	9,000	1	15	60
Gulf	3,800	0	4,500	1	8,300	1	3	11
Superior Oil Company	7,260	1	0	0	7,260	1	--	--
Shell	6,180	13	0	0	6,180	13	8	16
Pan Am (Standard, Indiana)	2,790	1	0	0	2,790	1	6	15
Tenneco Incorporated	1,180	1	0	0	1,180	1	9	32
Marathon Oil Company	760	1	--	--	760	1	18	109
Total	214,440		24,340		238,780			

1/ Approximation.
2/ Rank by 1971 assets in petroleum industry.
3/ Rank by 1971 sales among 500 largest industrials.
4/ Number of Noncontiguous tracts.

NOTE: Data includes all of the lands currently held by major oil companies. Other lands have been patented and are mostly in individual ownership.

capital will establish the economic parameters. If, in combination, these are judged favorable by private enterprise, development may be initiated at a given location.

Should it be initiated, development would probably be limited to one or two plants. This is due to the pioneering nature of oil shale development where, in mineral resource development, second generation operators are often more successful than the pioneer resource development company. The reasons for this are many, but relate directly to the greater amounts of technical and operating data, proven mining and processing systems, established environmental controls and procedures, availability of specialized equipment, and the possible availability of trained personnel. Thus, it is usually more advantageous to wait and observe development by the pioneer company before making a commitment to proceed with further development. For the scale of operations required for oil shale development, this wating period could exceed a decade or more, as is the case in a similar undertaking, tar sands development in Canada.

Planning for the current operations in Canada dates back to 1960 when Great Canadian Oil Sands, Ltd. (GCOS) applied to the Alberta Oil and Gas Conservation Board for permission to produce 31,500 barrels of oil daily from Canada's tar sands. This application was approved in 1962 and, in 1964, a production increase to 45,000 barrels per day was allowed.

Construction on the plant and supporting facilities began during the summer of 1964. The first production was achieved in September 1967. The plant cost was first estimated at $191 million, but the actual total cost was about $235 million. For nearly two years following first production, numerous technical problems were encountered. Production records indicate a steady improvement in operations beginning in 1969; 21,671 barrels per day for the first six months of 1969 and 33,003 barrels per day the second six months. Progress continued to improve and, over the first three quarters of 1972, the original target production level of 45,000 barrels per day was reached. Over the first quarter of 1973, the first profit for any quarter was reported. To this date, although many companies have filed applications for tar sand production, no other firm has attempted tar sands production on a commercial scale.

Another factor retarding development of private lands is the high concentration of lands in existing ownership. Approximately 60 percent of the private acreage is controlled by 5 firms and 77 percent by seven firms (see Table IX-3). The distribution between private and public lands has been presented in Volume I, Chapter II, Tables II-16, 17, and 18. Volume I, Chapter II which shows that the largest landowner is the Federal Government controlling 72 percent of the acreage and 80 percent of the resource. This difference between surface area and resource quantity is due to the nature of the public land which, in general, contain greater amounts of oil per

acre than do the private lands because the thickness of the deposit is greater. Thus, the public lands offer some of the best opportunities for the development of viable economic processes. For this reason, a private developer will continue to be reluctant to develop private lands first so long as the possibility exists that at some future date, as a result of leasing public lands, the high grade resources would be available to potential competitors as well as whatever information the pioneering company had already developed. This situation has been assessed by the National Petroleum Council (11, p. 156) which has concluded that without the availability of public lands, development may be limited to one or possibly two plants with a combined production of 100,000 barrels per day by 1985, even though the potential is considerably greater.

Development on private lands would, however, produce important information on the environmental aspects of oil shale development. Much of these data, if made available, would be directly applicable to development on public lands. These relate primarily to physical factors which are not directly related to a specific location, e.g., the stability of waste disposal piles and its potential contribution to salt and sediment loading of local waters due to leaching and/or erosion. Other data, such as that relating to mine dewatering, air quality impacts, and impacts on fauna, would be only partially applicable, or not applicable at all, due in large measure to differences in the characteristics of the resource found on private and on public lands as explained below.

In general, the private lands are located near the southern margins of the Piceance Creek Basin while the public lands are concentrated near the center. This distinction is important since it relates to the characteristics of the oil shale deposits detailed in Volume I, Chapter II, Sections B.3, B.4, and B.5. As discussed in the references sections, nearly all of the oil shales of potential commercial interest are contained in the Parachute Creek Member. This member gradually increases in total thickness from 200 feet near the margins of the basin to more than 1,500 feet near the geographic and depositional center of the basin (see Cross-Section, Volume I, Chapter II, Figure II-33). The upper oil shale zone within the Parachute Creek Member contains the most widespread rich oil shale unit,the Mahogany Ledge. The ledge is found on both private and public lands and is some 70 feet in thickness where it outcrops in the south. Here, the Mahogany has been mined for experimental work by the Bureau of Mines, Union Oil Company, Colony Development Operation, and Occidental Petroleum Company at different locations. The lower oil shale zone within the Parachute Creek Member is absent or of such low quality that it is not of economic interest on most privately held lands. However, this lower zone increases in thickness from a few feet at the margins of the basin to more that 1,000 feet near the depositional center. With the increased thickness, there is also a corresponding increase in the richness of the oil shale. In some areas, the lower oil shale zone contains several units that are as thick and as rich as the Mahogany Zone.

Contained also in the lower zone are most of the economically significant quantities of nahcolite and dawsonite, nearly all of which are on public lands.

The amount and movement of ground water through the Parachute Creek Member generally coincides with the geologic conditions outlined above. Some 25 million acre-feet of water may be in storage in the basin most of which is contained in the thick oil shale deposits located near the depositional center. Water has been absent in the experimental mines discussed above and, based on the ground water analysis detailed in Volume I, Chapter II, Section B.5.b it is not likely that large quantities would be encountered on the private lands. Since mine dewatering would probably be limited on private lands, the opportunity to test various methods of managing large quantities of excess water to process needs on a commercial scale throughout the region would exist only on public lands.

Environmental Impacts

Much of the private land is more easily accessible by paved highways and secondary roads than are the public lands. Thus, the impacts due to construction would be expected to be somewhat less than those impacts discussed in this volume in Chapter IV. Development to the 100,000-barrel-per-day level could therefore require less than the 200 to 600 acres estimated to be needed for access and utility corridors for a single plant on public lands. Construction impacts, however, are relatively temporary and not as significant as those impacts associated with actual operations.

The private lands are characterized by high canyon walls as compared to the more gently rolling topography that characterizes much of the public lands. This characteristic would reduce the amount of land required for disposal, as described in Chapter III of this volume. For example, one investigator for a private firm, Colony Development Operation, reports that (12, p.2):

> "The canyons are well over one thousand feet deep,... Colony's presently contemplated disposal embankment would be placed in one of thse valleys, which twenty years of production would about half fill. This particular valley, called Davis Creek, has a very small watershed, and a very low flow stream; the flooding hazard is minimal and easily controlled. When the embankment is shaped to blend with the landscape, and covered with native vegetation, it should blend with the topography....

Revegetation may be somewhat more difficult if the elevation of the waste disposal sites associated with private land development is lower than that of the public lands.

The topographic characteristics of the private lands will also increase the probability of pollutants being trapped under conditions of inversion discussed in Chapter IV, Section C, of this volume. The amount of pollutants emitted by a 100,000-barrel-per-day (or two 50,000-barrels-per-day) operation(s) would be approximately as follows: airborne particulates, 1 ton per day; sulfur dioxide, 49 to 93 tons per day; and oxides of nitrogen, 4 to 6 tons per day. These may be trapped under an inversion and then be forced to the earth under the heating-cooling cycle common to the oil shale region. If the plant is located near the base of the canyon, greater damage to vegetation and subsequent effects on animals would be expected than those impacts detailed in Volume I, Chapter III, Section D.3.

In general, the impacts of development on grazing, wildlife, and recreation would be expected to be about the same as those described in Chapter IV, Sections E, D, and F, since many of the private lands contain similar vegetative, faunal, and grazing values as the public lands. An exception to this generalization is the White River deer herd of the Piceance Creek Basin which winters mainly in the lower elevations of the basin and moves to the higher elevations in and to the east of the basin during the summer months. The effects on this traditional pattern of movement would probably not be affected by development of oil shale on private lands.

Since about the same number of people would be required to construct, operate, and support an oil shale operation of a given size, impact on the region's socioeconomic resources would be similar for development on either private or public lands. Thus, this impact would be about as described in Chapter IV, Section H of this volume.

Because the edges of the Basin and the high canyon walls are generally well drained, dewatering problems would not likely be encountered on many of the private lands. Therefore, large quantities of water would not need to be pumped to keep the mine workings dry. The potential impacts of mine dewatering as discussed in Chapter IV, Section B of Volume III (water level declines in wells and the drying of springs and reduction in species) would therefore be less or non-existent. However, nearly all water required for development would need to be pumped to the private holdings, probably from the Colorado River, increasing the impacts of consumptive use and surface water development.

In assessing this alternative, it should be recognized that oil shale development on private lands would necessarily proceed under applicable State, Federal, and local laws designed to protect the environment. These would mitigate environmental damage, but the special environmental stipulations and requirements for monitoring contained in Chapter V of this volume would not be applicable unless private development required the issuance of other Federal permits which would provide the opportunity to impose environmental stipulations. In addition, the private owner is not under the same obligation to share the detailed cost and environmental information with Government officials.

Of particular importance is the degree to which information developed on private lands would be applicable to the public lands. By virtue of geographic location and topography, most private lands offer limited options for mine development in the Mahogany Ledge. Development on a commercial scale is feasible using the room-and-pillar method that has been demonstrated for this oil shale formation. However, techniques to develop the thicker oil shale deposits that occur on public lands would not be developed. These deposits, as discussed above, contain substantial amounts of water that must be withdrawn and managed for either a surface mine or an underground mine located in Colorado. The potential impacts associated with this cannot be assessed by development on private lands.

Private land development would yield a considerable amount of environmental information that is directly applicable; e.g., the

impacts of spent shale disposal areas, the impacts of air pollutants, and the impacts caused by construction. However, since private lands would probably be unable to support a full range of development options due to the location and characteristics of the private resources, development on private lands would not yield the complete range of environmental information required to establish the basis for subsequent leasing decisions.

F. Open Leasing

One alternative to the proposed action of a prototype leasing program would be for the Department to implement an open leasing policy permitting the companies interested in oil shale development to acquire rights and start development as soon as possible at a rate that they themselves select. Open leasing is defined as the Department issuing leasing regulations, and then offering as competitive leasing such acreage as might be nominated by private interests.

Such a leasing policy would still limit, under the Mineral Leasing Act of 1920, any company or individual to a maximum of one 5,120 acre lease or equal accumulated leased acreage in several leases if they were not the lessee. Such a policy would require all actions to be in accord with applicable Federal and State regulations; however, the manner of bidding and terms of the lease might be different than that considered under the proposed prototype program. These options have been detailed in the Department's 1968 publication entitled Prospects for Oil Shale Development (13).

The specifics of an open leasing policy will not dictate the initial rate at which oil shale can be developed. As discussed in Volume I, Chapter II, Section A, the rate of development will be established by physical limitations such as the logistics of plant construction, hiring and training operating personnel, and the construction of supporting urban facilities such as housing and schools. Thus, the rate of development cannot be expected to exceed the development levels discussed in Volume I, that is, a maximum production level of 1 million barrels per day by 1985. In any event, an open leasing policy would preclude the opportunity for planned, orderly development of the oil shale resources and would also conflict with sound management of the other public resources of the region.

Environmental Impact

The impacts of an open leasing policy would be substantially greater than the impacts from the program described elsewhere in this volume since it would probably involve considerably more than six leases. The impacts would be more regional in character and would cause significant changes in the uses of the land and water resources similar to those described in Volume I. After 1985, public land would be available in significant amounts to increase the level of production over the 1-million-barrel-per-day level. On the other hand, under the program as proposed, a maximum production of 250,000 barrels-per-day is all that is expected from the six prototype tracts combined and additional public lands would not be considered for leasing until additional analysis of the possible environmental impacts of a mature industry has been conducted.

G. Alternative Tracts

Section A of this chapter has outlined the expected results of the proposed program while Sections B through F have described alternatives to the proposal. The present section describes alternatives to the tracts selected as those best able to attain the objectives of the proposed program. The section immediately following, H, details the procedure used to evaluate the nominated tracts, including a comparative evaluation of the resource potential of each tract and potential environmental impacts.

In 1971, private industry submitted 23 nominations of oil shale lands for possible leasing to the Department of the Interior. Due to multiple nominations of several tracts, they were identified as 18 separate tracts, 13 in Colorado, 4 in Utah, and 1 in Wyoming. The single nomination in Wyoming was supplemented by a nomination from the Governor of 2 additional tracts resulting in a total of 20 nominated tracts. All 20 tracts are described in this subsection. In addition, the potential environmental impacts are described for all tracts except those 6 tracts recommended for this prototype program. Those impacts are discussed in Chapter 4 of this volume.

The descriptive material which follows may repeat some aspects of the description of the environment already set forth in Chapter II for Tracts C-a and C-b in Colorado, U-a and U-b in Utah, and W-a and W-b in Wyoming. However, all 20 tracts are discussed in this section to facilitate cross-reference and comparison. The tracts

are discussed state by state and the tract identification numbers used by the field committee are retained. These tract numbers are also used in Table IX-3 in Section E.3. of this chapter where geologic, resource and mining factors are tabulated. The tracts' geographic relationships in the three regions are portrayed in Figures IX-3, IX-16, and IX-20. Individual maps following each tract discussion show the orientation and relationship of that tract to its immediate surrounding area.

1. Colorado Tract Alternative C-1

Description

Tract C-1.- This tract lies south of the White River between Yellow Creek and Calamity Ridge (See Figure IX-3). Its legal description covers a total of 5,120 acres, more or less, consisting of the following lands:

T. 1 N., R. 98 W., 6th P.M. Rio Blanco Co., Colo.

Section:	14	-	All
	15	-	All
	16	-	E½
	21	-	E½
	22	-	All
	23	-	All
	26	-	W½
	27	-	All
	28	-	E½
	33	-	NE¼
	34	-	N½
	35	-	NW¼

The entire tract is public domain. PLO 4536 withdrawal AEC Experimental Site covers the SW¼ Sec. 14, SE¼ Sec. 15, NE¼ Sec. 22, and NW¼ Sec. 23, Sec. 14, SW¼SW¼ is covered by a SLUP.[1/] The tract has no mining claim conflicts.

Elevation. Tract elevation ranges from 6,200 feet to 6,700 feet above mean sea level. North-facing slopes subject to freezing.

Climate. Average annual rainfall is 15 to 17 inches. Annual temperature range is -40°F to +95°F. Approximate mean temperature is 45°F.

1/ SLUP is the abbreviation for "Special Land Use Permit.

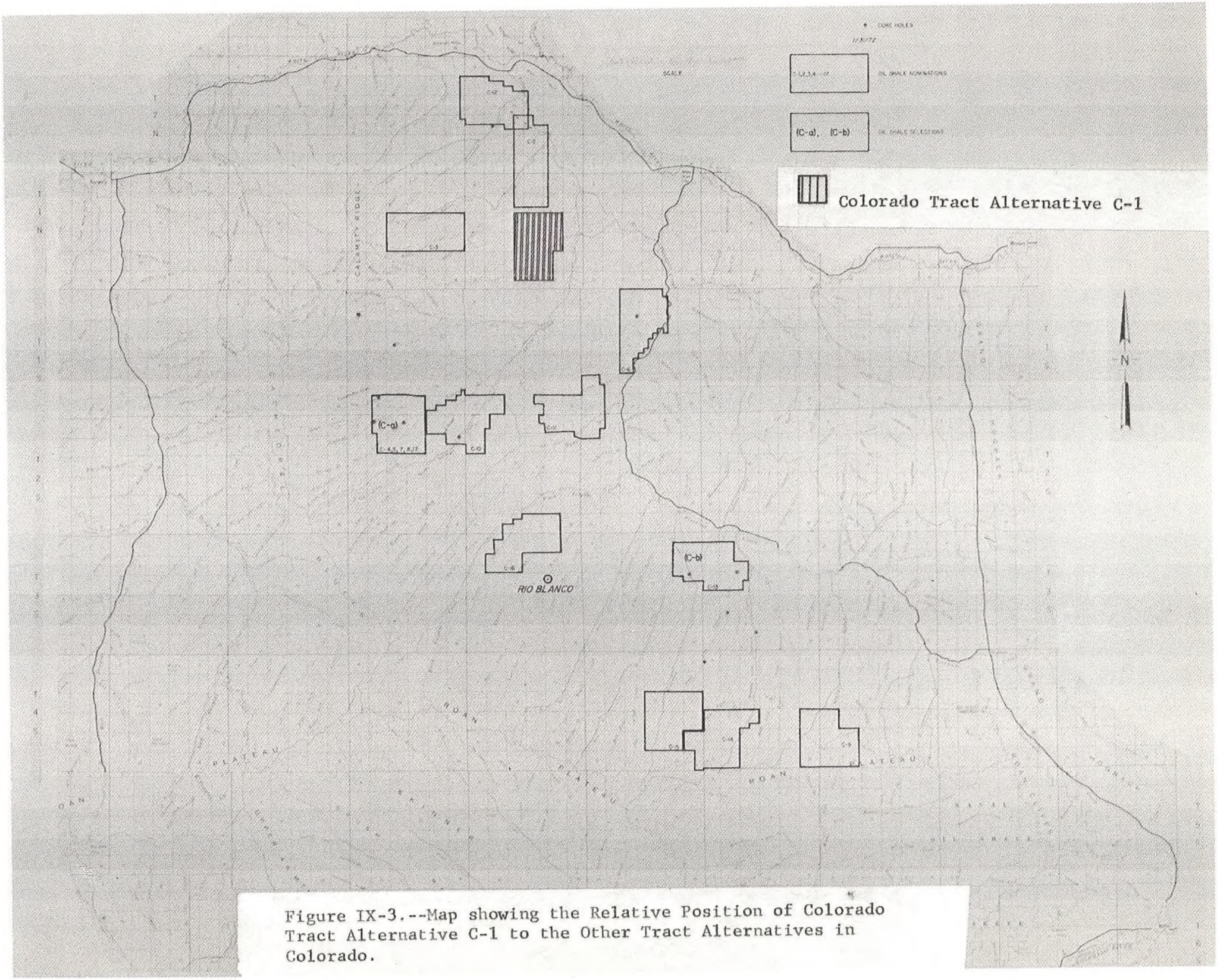

Figure IX-3.--Map showing the Relative Position of Colorado Tract Alternative C-1 to the Other Tract Alternatives in Colorado.

Access.- The most direct access to the center of the tract is from the Piceance Creek Highway to Rio Blanco County Road No. 122, thence to BLM Road No. 1093. These are public roads with no excessive grades.

Vegetative Type.- Pinyon-juniper and sagebrush are the major vegetative types in this area. The sagebrush occurs in the drainage bottoms along with rabbitbrush. At the lower elevations, the bottoms have greasewood interspersed with the sagebrush. The pinyon-juniper occurs on the slopes and ridges.

Geologic Features:

(1) Alluvium.- Percent of area is less than 10 percent. Its composition consists of clay, silt, sand marlstone fragments with a thickness of 0 to 100 feet.

(2) Evacuation Creek Member of the Green River Formation.- Percent of area, 100 percent. Its composition consists mostly of calcareous sandstone and siltstone with minor amounts of marlstone. Thickness ranges from 700 feet to 1,450. Some zones contain a high percent of analcime; extractable alumina may be present.

(3) Parachute Creek Member of the Green River Formation.- Percent of area, 100 percent. Its composition consists mostly of oil shale, minor amount of nahcolite, some halite, thin beds of analcime, with a thickness of 1,500 feet $\pm$

(4) Structure.- No faults apparent. The rocks strike approximately N 45° W., and the dip is to the NE at the rate of about 200 feet per mile.

(5) Hydrology.- A test hole in SW¼SW¼SW¼, Sec. 14, T.1 N., R. 98 W., indicated that the upper zone contains water with an electrical conductance of 800 umhos/cm and has a transmissivity of 4,200 gpd/ft. The upper zone has a transmissivity of 2,000 gpd/ft and contains water with an electrical conductance of 25,000 umhos/cm.

(6) Mineral Value:[1/]

(a) Mahogany Zone.-Contains approximately 60 feet of oil shale in two zones 40 and 18 feet thick, averaging 30 gallons of oil per ton with an in-place resource of about 120 thousand barrels of oil per acre.

(b) Lower Oil Shale Zones R-1 through R-6: (See Figure II-35, Chapter II, Volume I).- About 440 feet of section contains oil shale averaging 30 gallons of oil per ton with an in-place resource of about 880 thousand barrels of oil per acre. More than a 700 foot interval contains nahcolite and dawsonite of varying amounts. Several hundred feet of section immediately underlying the Mahogany ledge that formerly contained nahcolite and possible halite has been leached by underground water that now occupies the voids created by the leaching and is of poor quality. This saline aquifer could present difficult problems in the mining of a total of 60 feet of 30 gallon shale and several hundred feet of dawsonite shale. In addition, the presence of thin beds of halite will discourage mining in an additional 100 or so feet of oil shale containing nahcolite and dawsonite immediately underlying the leached zone.

1/ Average approximately, but not less than 30 gallons/ton. Intervals greater than 10 feet thick and averaging less than 15 gallons/ton were not considered. This same criteria was used for all averaging of oil shale (gallon/ton) in this statement.

<u>Air and Water Quality Characteristics</u>:

(1) Surface Water Quality.- The tract is located close to the middle reaches of the Yellow Creek drainage where surface water quality is deteriorating from ground water discharge as the stream nears the White River.

(2) Air Quality.- The low, middle basin location places the tract in area of probable nighttime temperature inversions. Further, proximity to the White River places the tract close enough to inhabitated areas to be within range of pollutants carried toward Rangely by drainage winds. The present air quality is high, generally free of contaminants.

<u>Transportation Network</u>:

(1) Roads.- Existing roads are described under "Access." A jeep trail crosses the tract from the east to the west side of a NE to SW direction, connecting with similar unimproved road to Calamity Ridge to the west.

(2) Pipelines.- None on the tract.

<u>Power Sources</u>.- The nearest electric power is located along the valley of Piceance Creek approximately 6 air miles east of the tract. This is a general service line, 7000V primary. High voltage transmission lines exist 12 miles north of the tract. Telephone facilities are available 12 miles north or 6 miles east.

<u>Land Use</u>.- Present land use consists of livestock grazing and wildlife habitat.

Vegetation and Soils.- The drainage bottoms are characterized by deep, light-colored soils low in organic matter. These soils generally contain free salts in their profile and support stands of greasewood and other plants which can tolerate these salts. The ridges have a very shallow, light-colored soil over sandstones and shales. There are large inclusions of deep, dark loam soils on the exposures suitable for development of deeper soils.

The shallow soils support stands of pinyon and juniper trees with a sparse understory of perennial grasses and various shrubs. The deeper soils support heavy stands of sagebrush with an understory of perennial grasses.

Plant Species:

(1) Browse

Amelanchier utahensis	Serviceberry
Purshia tridentata	Bitterbrush
Artemisia tridentata	Big sagebrush
Cercocarpus montanus	Mountain mahogany
Atriplex spp.	Saltbush
Chrysothamnus spp.	Rabbitbrush

(2) Grasses

Oryzopsis hymenoides	Indian ricegrass
Agropyron inerme	Beardless bluebunch wheatgrass
Koeleria cristata	Prairie junegrass
Poa spp.	Bluegrass
Elymus cinereus	Basin wildrye
Stipa comata	Needle and thread

(3) Trees

Pinus edulis	Pinyon pine
Juniperus osteosperma	Juniper
Quercus gambellii	Scrub oak

Vegetation Conditions.- Conditions are fair to good on vigor. The adaptability for revegetation is limited by shallow soils on ridges and slopes.

Wildlife.- Mule deer are numerous particularly in the winter. Mountain lion, coyote, bobcat, chukar, doves, rabbits, raptors, plus numerous small bird and mammal species also exist on the tract. The tract and the surrounding area also has been utilized by wild horses for winter range. The wildlife in this remote area are subject to little disturbance from agricultural or recreational activities.

Livestock Grazing.- One operator has 200 head of cattle grazing on the tract during the spring and fall each year which produce 500 AUM's per year.

Improvements.- There are no major improvements on this tract or within the immediate vicinity. Fences, wells, and tree chaining areas can be noted.

Archeology.- The entire region is known to have been inhabited by Ute Indians, at one time; however, no artifacts are known or reported on the tract.

Recreation and Esthetics. - The area is used primarily for hunting. Major recreation values are based upon wildlife use.

Environmental Impact of Development

If this tract was developed by underground mining (for which it is suited), the following impacts on the tract environment appear likely:

Water.- The impact on water supply and quality could be expected to be similar to those described for Tract C-b in Chapter IV, Section B.

Land.- The impact on land could be expected to be similar to that described for Tract C-b which also drains only a short distance north and east before reaching Piceance Creek, a stream similar to Yellow Creek. C-1 is about 500 feet lower in elevation than C-b but of the same topography, cut by a major east-west canyon, Pine Gulch. Waste disposal areas exist nearby but are fewer in number than around C-b. It is likely that somewhat more road and pipeline contamination for waste handling will be required which would cause slightly greater off-tract effects.

Air.- The low mean altitude, nearness to Yellow Creek Canyon and occurrences of nighttime winter temperature inversions offer potential for local effects on air quality in the tract vicinity. This would be in addition to any possible effects on the general area around the point of average maximum concentrations anticipated by the smoke plume model (See evaluation in Volume 1, Chapter III, Section 3 (b)). The Yellow Creek lower valley and possibly the White River Valley in places would receive effects. Meeker and Rangely receive haze from particulates during prevailing wind periods.

Wildlife.- Wildlife would be significantly impacted by development of Tract C-1. The potential wild horses (50 to 60 head) would be interfered with, and possibly prevented in the area due to construction of roads, traffic, fencing, human habitation and movement,

and equipment operation. The State of Colorado Wildlife Management Unit (26,000 acres, plus 124,000 acres cooperatively managed land with other owners) would receive heavy industrial development in the central part of the winter mule deer range and areas managed for the chukar partridge. Penetration of wildlife habitat could occur.

Vegetation.- The impact would be similar to that described for Tract C-b in Chapter IV, Subsection A-5.

Grazing.- It is probable that one operator grazing 200 head of cattle and utilizing 500 AUM's spring and fall each year on the area would be required to move his operations.

Recreation.- Hunting would be excluded over much of the tract and over time, the effects on wildlife from industrial development in the area would lower the population of mule deer and other game and render the area less desirable for hunting than at present.

Cultural Features.- The one existing unimproved road would likely become an improved road through the tract and ultimately, if sufficiently accessible to the public, open up public access to the Calamity Ridge area west of the tract. The road is scenic and development could impair the area's esthetic appeal.

Minerals.- The presence of nahcolite and dawsonite in the shale beds in significant quantity could lead ultimately to development of these mineral resources in addition to oil shale. Nearness of the tract to private oil company lands to the east might also stimulate private land development for oil shale and related minerals. Oil shale resources that would be affected by development approximate 1 million barrels per acre.

<u>Archeological and Historical</u>.- There is no evidence to indicate any effect would occur; however, known historical use in the Basin by Ute Indians indicates the possibility of impact on artifacts and other archeological resources.

<u>Socio-Economic</u>.- The impact would be expected to be similar to that occurring from development of Tract C-b.

2. COLORADO TRACT ALTERNATIVE C-2

Description

Tract Alternative C-2.- This tract lies immediately north of Tract C-1 and is intersected by Yellow Creek in the northeast corner. Barcus Creek flows through the tract from southwest to northeast intercepting Yellow Creek at the east boundary line (Figure). Its legal description covers a total of 5,120 acres, consists of the following described lands:

T. 2 N., R. 98 W., 6th P.M. Rio Blanco Co., Colo.

Section: 21 - E½
22 - W½, SE¼, W½W½NE¼
23 - W½SW¼
26 - W½W½
27 - All
28 - E½
33 - E½
34 - All
35 - W½W½

T. 1 N., R. 98 W., 6th P.M. Rio Blanco Co., Colo.

Section: 2 - W½W½
3 - All
4 - E½
9 - NE¼, N½SE¼
10 - N½, N½S½
11 - W½NW¼, NW¼SW¼

The tract is entirely on public domain land and overlaps Tract C-12 by approximately 320 acres in the northwest corner. Pre-1920 mining claims cover E½ Sec. 21, T. 2 N., R. 98 W. Post-1920 mining claims cover all lands in T. 2 N., R. 98 W.

Elevation.- The elevation ranges from 5,000 feet to 6,000 above mean sea level.

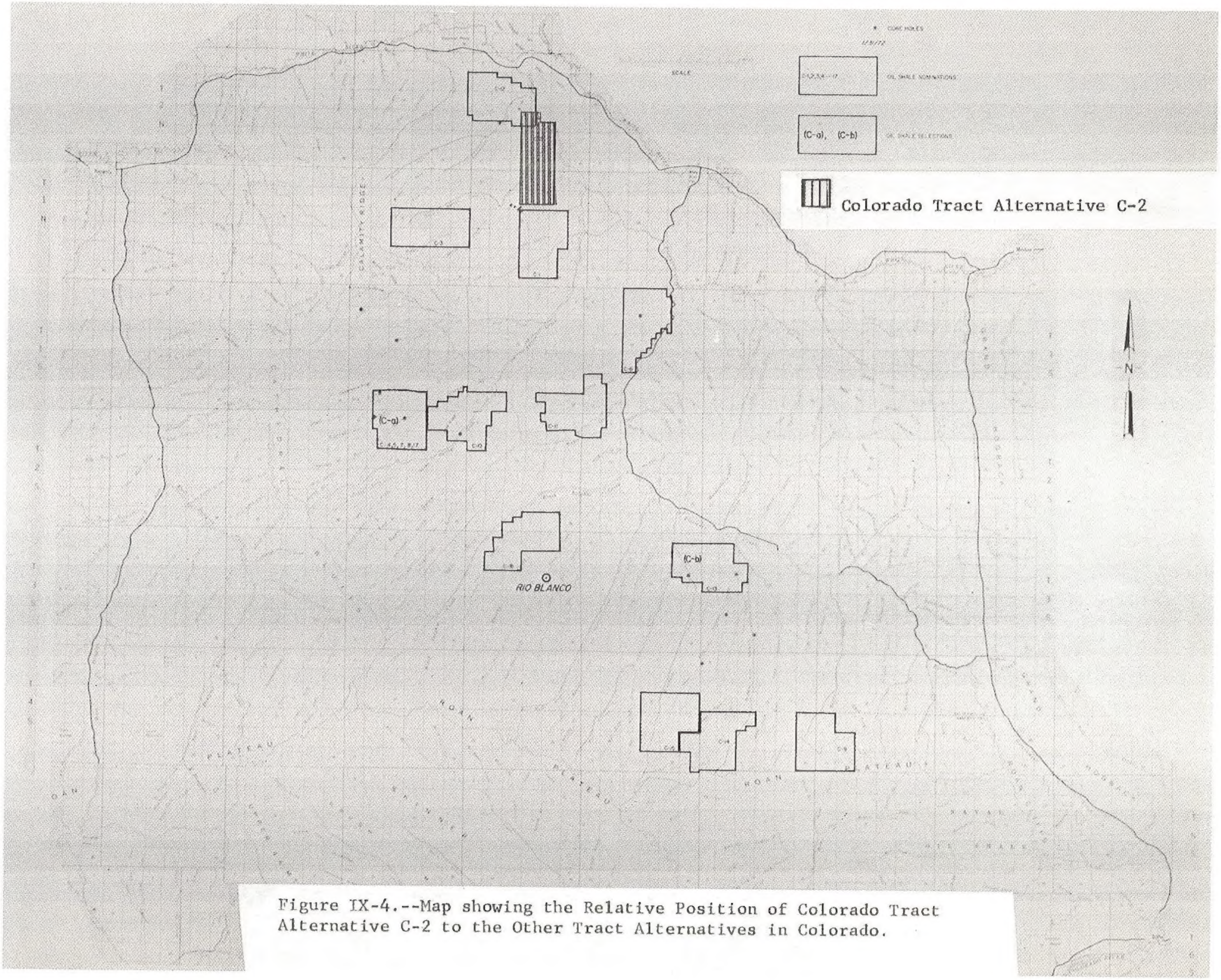

Figure IX-4.--Map showing the Relative Position of Colorado Tract Alternative C-2 to the Other Tract Alternatives in Colorado.

Climate.- Average annual rainfall is 15 to 17 inches. The annual temperature ranges from -40°F to +95°F seasonally. The approximate mean annual temperature is 45°F.

Access.- The present route to improved roads from the center of this tract is down Barcus Creek for approximately 1.5 miles to the junction of Barcus Creek and Yellow Creek, then upstream along the Yellow Creek drainage for approximately 3.5 miles to the junction of BLM Road No. 1093 and County Road No. 122, then 4 miles east to Piceance Creek, a total of approximately 9 miles.

Vegetative Type.- Pinyon-juniper and sagebrush are the major vegetative types in this area. The sagebrush occurs in the drainage bottoms along with rabbitbrush. At the lower elevations, the bottoms have greasewood interspersed with the sagebrush. The pinyon-juniper occurs on the slopes and ridges.

Geologic Features:

(1) Alluvium.- Percent of area is less than 10 percent. Its composition consists of clay, silt, sand, marlstone fragments. The thickness is 0-100 feet.

(2) Evacuation Creek Member of the Green River Formation.- Percent of area, 90 percent. Its composition consists mostly of calcareous sandstone and siltstone with minor amounts of marlstone. Thickness ranges from 0-1,400 feet. Some zones contain a high percent of analcime; extractable alumina may be present.

(3) Parachute Creek Member of the Green River Formation.- Percent of area, 100 percent. Its composition consists mostly of oil shale, minor amounts of nahcolite and sandstone, and thin beds of analcime.

(4) Structure.- A northwest trending normal fault of small displacement extends into the center of the tract. The axis of a northwest trending syncline comes into the south one-third of the tract. The strike in most of the area is mainly to the northwest. The dip is southwest at a rate varying from 150 feet per mile in the southern two-thirds to more than 600 feet per mile in the north end.

(5) Hydrology.- No hydrologic data are available for this tract. It is estimated to be similar to Tract C-1.

(6) Mineral Value.- The following data is based on information gathered from areas outside the nominated tract:

(a) Mahogany Zone.- No interval thicker than 10 feet, averages 30 gallons of oil per ton. The Mahogany zone contains small amounts of extractable alumina.

(b) Lower Oil Shale Zones R-1 through R-6 (Figure II-35, Chapter II, Volume 1).- Less than 100 feet of shale in the lower zone averages 30 gallons of oil per ton. There is probably bedded nahcolite in the southern one-third of the tract and minor amounts of nahcolite in pods in the remainder of the tract. Dawsonite is contained in varying amounts through several hundred feet of section. Probably no halite underlies the tract.

Air and Water Quality Characteristics:

(1) Surface Water Quality.- Located near the lower reaches of the Yellow Creek drainage where surface water has a high total dissolved solids (TDS) content, in part from ground water discharge.

(2) Air Quality.- The low, middle basin location places the tract in an area of likely temperature inversions. The present air quality is high, generally free of contaminants.

Transportation Network:

(1) Roads.- Existing roads are described under "Access." Alternative access can be provided by a road up Yellow Creek.

(2) Pipelines.- None in vicinity.

Power Sources.- Natural gas supply is available 6 miles to the north. The nearest power source for this tract is along the valley of the White River due north approximately 3 air miles over Blair Mesa. Telephone facilities are available 3 miles to the north.

Land Use.- Present land use consists of livestock grazing and wildlife habitat.

Vegetation and Soils.- The drainage bottoms are characterized by deep, light-colored soils low in organic matter. These soils generally contain free salts in their profile and support stands of greasewood and other plants which can tolerate these salts. The ridges have a very shallow, light-colored soil over sandstones and shales. There are large inclusions of deep, dark loam soils on the exposures suitable for development of deeper soils.

The shallow soils support stands of pinyon and juniper trees with a sparse understory of perennial grasses and various shrubs. The deeper soils support heavy stands of sagebrush with an understory of perennial grasses.

Plant Species:

(1) Browse

Amelanchier utahensis	Serviceberry
Purshia tridentata	Bitterbrush
Artemisia tridentata	Big sagebrush
Cercocarpus montanus	Mountain mahogany
Atriplex spp.	Saltbush
Chrysothamnus spp.	Rabbitbrush

(2) Grasses

Oryzopsis hymenoides	Indian ricegrass
Agropyron inerme	Beardless bluebunch wheatgrass
Koeleria cristata	Prairie junegrass
Poa spp.	Bluegrass
Elymus cinereus	Basin wildrye
Stipa comata	Needle and thread

(3) Trees

Pinus edulis	Pinyon pine
Juniperus osteosperma	Juniper
Quercus gambellii	Scrub oak

Vegetation Conditions.- Conditions are fair to good on vigor. The adaptability to revegetation is limited by shallow soils on ridges and slopes.

Wildlife.- Mule deer are numerous particularly in the winter. Mountain lion, coyote, bobcat, chukar, doves, rabbits, raptors, plus numerous small bird and mammal species also exist on the tract. The wildlife habitat is important winter range for mule deer. The tract and the surrounding area also have been utilized by wildhorses for winter range.

C-2 is a remote area having little agricultural or recreational activity. It is probable that eagle nesting sites also exist on the tract.

Livestock Grazing.- One operator has 200 head of cattle grazing on the tract during the spring and fall each year. 500 AUM's are available each year.

Improvements.- There are no major improvements on this tract or within the immediate vicinity.

Archeology.- No evidence of any archeological resources, however, it is known that the Ute Indians once inhabited the entire basin.

Recreation and Esthetics.- Primary recreational use of the area is hunting. Major recreational values are derived from wildlife use.

Environmental Impact of Development

Development by the underground recovery method for which it appears suited would probably have the following impacts upon the environment.

Water.- Ground water in the leached zone would affect mining. The impact on water supply and quality could be expected to be similar to that described for Tract C-b. Yellow Creek, and the White River might ultimately be affected by changes in flow and salt loading.

Land.- The impact on land also should be similar to that described for Tract C-b.

Air.- The impact on air quality should be about similar to that described for Tract C-1. Under inversion conditions, air quality affects would be felt in the Yellow Creek lower drainage and part of the White River valley.

Wildlife.- As with Tract C-1, wildlife would be significantly affected from the same causes; penetration of remote habitat, traffic, fencing, human habitation, noise, equipment operations, cover destruction. The effects on the deer herds, mountain lions,

small game and birds and the wild horse range should be similar to that described for Tract C-1. Some golden eagle habitat areas also may be lost, with ultimate reduction of the eagle regional population.

Vegetation.- Removal effects would be approximately as described for Tract C-a. Revegetation could be more difficult due to poorer soil and tract conditions over approximately 50 percent of the tract.

Grazing.- This impact would be similar to that described for grazing on Tract C-1.

Recreation.- The impact on outdoor recreation would be similar to that described for Tract C-1.

Cultural Features.- No significant effects would be anticipated. Effects on the well, noted within the tract, are covered in the water impact description.

Minerals.- The effects would be expected to be about the same as those described for Tract C-1 for nahcolite and dawsonite development and related private industry. Oil shale resources of 30 gallons/ton that would be affected by development are approximately 200,000 barrels per acre based on estimated thickness of 100 feet.

Archeological and Historical.- There is no evidence to indicate any effects should be anticipated; however, as the entire basin was once inhabited by the Ute Indians, some impact on artifacts might be expected.

Socio-Economic.- The impact would be expected to be similar to that occurring with development of Tract C-b.

If Tract C-2 were developed by the in situ method, or a combination of underground plus in situ, the impacts would be similar to those just discussed but with the following differences:

Water.- The effects on water quality would be approximately the same as described for in situ development of Tract C-13.

Land.- Less surface disturbance would occur since only 5 percent of the shale oil production would be by underground mining and the remainder by in situ. Less waste disposal surface area would then be required. The same would apply to a full in situ operation.

Vegetation.- Not much revegetation as that required for C-b would be necessary due to the need for less waste disposal area, and less original vegetation would be destroyed. The effects would be about the same as those described for Tract W-a.

3. COLORADO TRACT ALTERNATIVE C-3

Description

Tract Alternative C-3.- This tract lies due west of Tract C-1. Barcus Creek flows generally northwest through the tract. (See Figure IX) Its legal description below totals 5,120 acres.

T. 1 N., R. 99 W., 6th P.M., Rio Blanco Co., Colo.

Section: 13 - All
14 - All
15 - All
16 - All
21 - All
22 - All
23 - All
24 - All

The tract is entirely on public domain land. Sec. 21, NE¼NW¼ is covered by a power tract reserve. The tract has no mining claim conflicts.

Elevation.- Tract elevation ranges from 6,500 feet to 7000 feet above mean sea level.

Climate.- Average annual rainfall is 15 to 17 inches. Annual temperature range is -40°F to +95°F. Approximate mean temperature is 45°F.

Access.- Access to Tract C-3 would be via Barcus Creek drainage to minimize surface damage. The distance would be approximately 7 miles down Barcus Creek to the center of Tract C-2, a total of 16 miles to Piceance Creek, using the same route outlined for Tract C-2. Access through private land in Yellow Creek would have to be

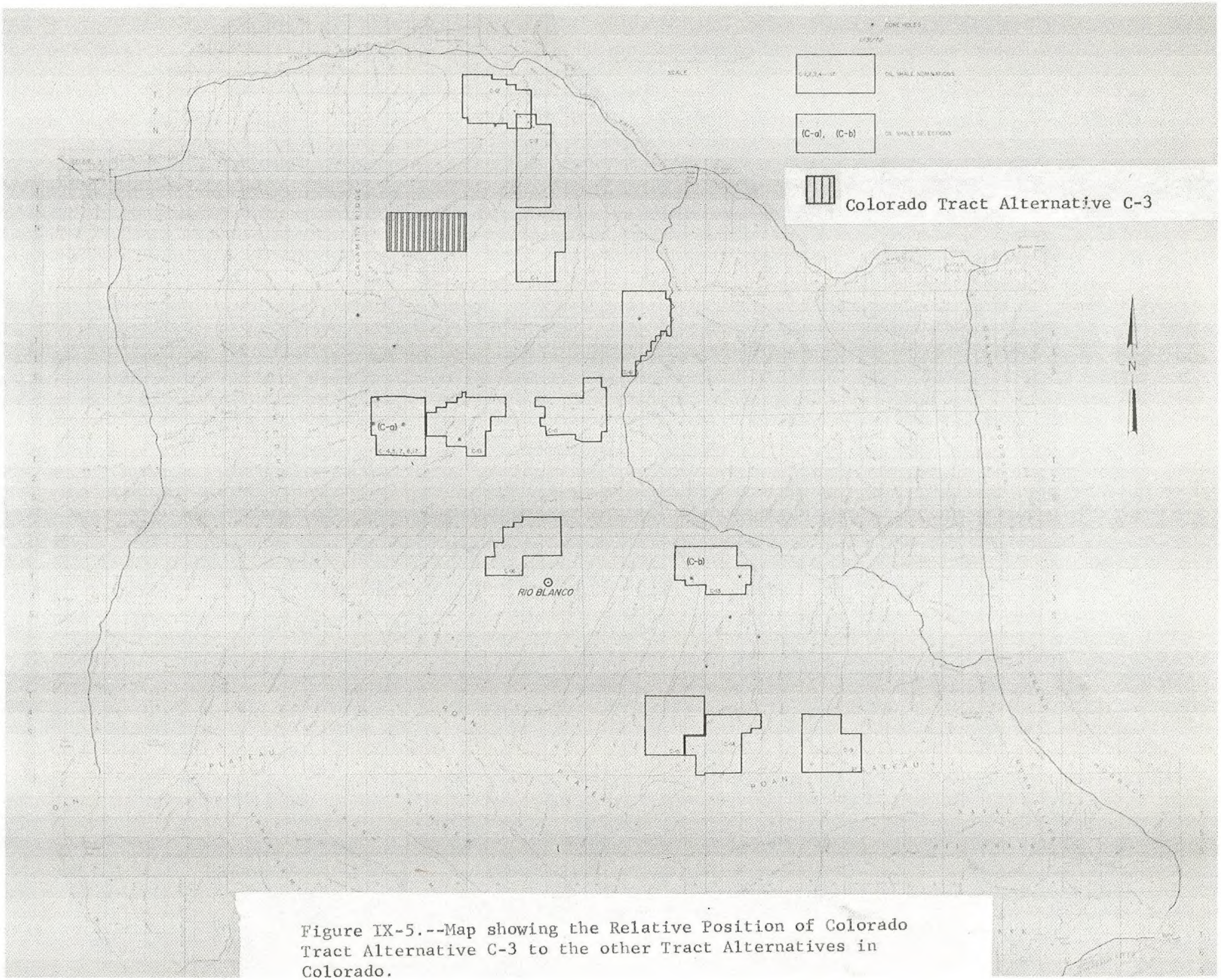

Figure IX-5.--Map showing the Relative Position of Colorado Tract Alternative C-3 to the other Tract Alternatives in Colorado.

obtained. An alternative route is up the drainage of North and Middle Barcus Creek to the Calamity Ridge road and then to Colorado Highway 64 and Rangely. This would involve the construction of one mile of new road.

Vegetative Type.- Same as Tract C-1. In addition, the western third of the area is characterized by mountain browse type.

Geologic Features:

(1) Alluvium.- Percent of area is less than 10 percent. Its composition consists of clay, silt, sand, and marlstone, with a thickness of 0 to 100 feet.

(2) Evacuation Creek Member of the Green River Formation.- Percent of area, 80 percent. Its composition consists mostly of calcareous sandstone and siltstone with minor amounts of marlstone. Thickness ranges from 0 to 800 feet. Some zones contain a high percent of analcime; extractable alumina may be present.

(3) Parachute Creek Member of the Green River Formation.- Percent of area, 100 percent. It is composed mostly of oil shale with minor amounts of sandstone in the western part, very little nahcolite in the west one-half, increasing amounts in the east one-half, and thin beds of analcime. Thickness is from 1,200 feet to 1,500 feet.

(4) Structure.- No faults are noted in the area. The strike is mostly to the north and northwest. The dip is to the east and northeast at rates varying from 500 feet to the mile on the west to 300 feet to the mile on the east.

(5) Hydrology.- A test well drilled in Sec. 20, T. 1 N., R. 99 W., penetrated the Parachute Creek Member but few hydrologic data were collected. The well yielded 35 gpm to a depth of 1,060 feet where all circulation was lost. The water quality is probably superior to that of Tract C-1.

(6) Mineral Value:[1/]

(a) Mahogany Zone.- Ranges from less than 10 feet of 30 gallon per ton shale in the west edge to more than 50 feet on the east edge.

(b) Lower Oil Shale Zones R-1 through R-6.- See Figure II-35, Volume I, Chapter II. Less than 100 feet of shale in the lower zone averages 30 gallons of oil per ton in the west part of the tract; shale thickens and values increase toward the eastern part of the tract. There is probably bedded nahcolite in the eastern part of the tract but not in the western part. Several hundred feet of oil shale contains dawsonite of varying quality.

Air and Water Quality Characteristics:

(1) Surface Water Quality.- The tract's location near head of Barcus Gulch suggests relatively high quality surface water.

(2) Air Quality.- High elevation minimizes the possibilities of stagnation or inversion but the northern location of the tract may present air quality problems for Rangely (because of drainage) and Meeker (because of the prevailing wind).

Transportation Network:

(1) Roads.- Existing roads are described under "Access."

(2) Pipelines.- None in the vicinity.

1/ Average approximately, but not less than 30 gallons/ton. Intervals greater than 10 feet thick and averaging less than 15 gallons/ton were not considered. This same criteria was used for all averaging of oil shale (gallon/ton) in this Statement.

Power Sources.- The nearest electric power source is at 84 Ranch approximately 8 air miles southwest of the tract. If a road has to be built alongside the powerline during construction, the powerline could be erected along existing roads for a portion of the route. Telephone service is available 12 miles north.

Land Use.- Present land use consists of livestock grazing and wildlife habitat.

Vegetation and Soils.- The drainage bottoms are characterized by deep, light-colored soils low in organic matter. These soils generally contain free salts in their profile and support stands of greasewood and other plants which can tolerate these salts. The ridges have a very shallow, light-colored soil over sandstones and shales. There are large inclusions of deep, dark loam soils on the exposures suitable for development of deeper soils.

The shallow soils support stands of pinyon and juniper trees with a sparse understory of perennial grasses and various shrubs. The deeper soils support heavy stands of sagebrush with an understory of perennial grasses.

Plant Species:

(1) Browse

Amelanchier utahensis	Serviceberry
Purshia tridentata	Bitterbrush
Artemisia tridentata	Big sagebrush
Cercocarpus montanus	Mountain mahogany
Atriplex spp.	Saltbush
Chrysothamnus spp.	Rabbitbrush

(2) Grasses

Oryzopsis hymenoides	Indian ricegrass
Agropyron inerme	Beardless bluebunch wheatgrass
Koeleria cristata	Prairie junegrass
Poa spp.	Bluegrass
Elymus cinereus	Basin wildrye
Stipa comata	Needle and thread

(3) Trees

Pinus edulis	Pinyon pine
Juniperus osteosperma	Juniper
Quercus gambellii	Scrub oak

Vegetation Conditions.- Conditions are fair to good on vigor. Revegetation is limited by shallow soils on ridges and slopes.

Wildlife.- Mule deer are numerous in the winter. Mountain lion, coyote, bobcat, chukar, doves, rabbits, raptors, plus numerous small bird and mammal species also exist on the tract. The wildlife habitat is important winter range for mule deer. The tract and the surrounding area also has been heavily utilized by wild horses for winter range. The wildlife in this remote area are subject to little disturbance from agricultural or recreational activities.

Livestock Grazing.- There are 565 head of cattle grazing on the tract during the summer - 500 AUM's are available.

Improvements.- No significant improvements on this tract or immediately within the vicinity.

Archeology.- None known are reported on the tract.

Recreation and Esthetics.- The area is used primarily for hunting. Major recreational values are based upon wildlife use.

Environmental Impact of Development

If this tract were developed by a combined method of in situ with underground mining, as recommended by the tract nominator, the following impacts upon the environment appear likely:

<u>Water</u>.- The impact on water supply and water quality would be similar to that described for Tract W-a inasmuch as 95 percent of the shale would be retorted subsurface by in situ methods. Some surface retorting and surface disposal could result in surface water effects because of erosion, leaching or accidental occurrence. The affected waters would generally be those of Greasewood Creek, Barcus Creek, and Yellow Creek.

<u>Land</u>.- The elevation and topography of the area are generally similar to Tract C-1. Surface disturbance of the land would approximate that of Tract W-a with the addition of an area buried by surface disposal of shale waste during the underground mining phase (about 5 percent of the reserves to be developed).

<u>Air</u>.- This impact should be similar to that expected from development of Tracts W-a and W-b except that previously described wind patterns and the inversion potential in the vicinity of the Yellow Creek air drainage offer the possibility of both Meeker and Rangely, Colorado, receiving low order emissions.

<u>Wildlife</u>.- Wild horses range the tract and could be driven away. Other wildlife affected would be mule deer, mountain lion, coyote, and bobcat, approximately the same as for Tract C-1. The area is a critical deer range in fall and winter.

<u>Vegetation</u>.- Vegetation of this tract is better than C-1 and C-2 due to a larger percentage of good soils (70 percent) over this tract. A relic juniper area exists which could be destroyed by development. The area has research and aesthetic value due to elevated location and age of the undisturbed stand. The amount of

vegetation affected by development would approximate that affected on Tract W-a. Erosion effects would be severe on soils of this tract.

Grazing.- Approximately 500 head of cattle utilizing summer range at a level of 500 AUM's would be affected and operations would have to be shifted elsewhere for the owner. There might be a loss of some benefits from recent range improvement project (chaining juniper areas and reseeding, for example).

Recreation.- Hunting and recreation access would be interferred with and hunting opportunity reduced through reduction of the mule deer herd and effects on small game and birds from development operations to the same degree as for Tract C-1.

Cultural Features.- Three unimproved roads approach or cross the tract from the Yellow Creek drainage into the Calamity Ridge area. Some public use could be affected by closing roads; others by road improvements.

Minerals.- The impact should be similar to that expected for Tract C-1. Oil shale resources that could be affected by development approximate 300,000 barrels per acre based on a thickness of 150 feet.

Archeological and Historical.- There is no evidence to indicate any effect should be anticipated; however, the entire basin was once inhabited by Ute Indians and the possibility of impact on artifacts exists.

Socio-Economic.- The impact would be expected to be similar to that associated with development of Tract W-a.

4. COLORADO TRACT ALTERNATIVE (C-4) (C-5, C-7, C-8, C-17)

Description

Tract Alternative C-4 (C-5, C-7, C-8, and C-17).- This tract received 5 separate nominations and thus 5 identifying numbers. (See Figure IX-6). It is tract C-a in the proposal covered in this Statement. Its legal description covers a total of 5,089.79 acres, described below:

T. 1 S., R. 99 W., 6th P.M., Rio Blanco Co., Colo.

Section: 34 - $S\frac{1}{2}$, $NW\frac{1}{4}$, $S\frac{1}{2}NE\frac{1}{4}$, $NW\frac{1}{4}NW\frac{1}{4}$
33 - All
32 - $E\frac{1}{2}$, $E\frac{1}{2}W\frac{1}{2}$

T. 2 S., R. 99 W., 6th P.M., Rio Blanco Co., Colo.

Section: 5 - $E\frac{1}{2}$, $E\frac{1}{2}W\frac{1}{2}$
4 - All
3 - All
8 - $E\frac{1}{2}$
9 - All
10 - All

The entire tract is public domain except for the following lands:

T. 1 S., R. 99 W., 6th P.M., Rio Blanco Co., Colo.

Section: 33 - $E\frac{1}{2}$, $E\frac{1}{2}SW\frac{1}{4}$, $SE\frac{1}{4}NW\frac{1}{4}$
34 - $N\frac{1}{2}$, $NW\frac{1}{4}SW\frac{1}{4}$

The above is patented with at least oil shale reserved to the United States. All of section 32 is covered by post-1920 placer claims; $E\frac{1}{2}$, $NW\frac{1}{4}$ of section 3 is covered by post-1920 placer claims; $W\frac{1}{2}$ of section 4 is covered by post-1920 placer claims; all of section 5 is covered by post-1920 placer claims; $E\frac{1}{2}$ of section 8 is covered by post-1920 placer claims; $W\frac{1}{2}$ of section 9 is covered by post-1920 placer claims; all of section 10 is covered by post-1920 placer claims.

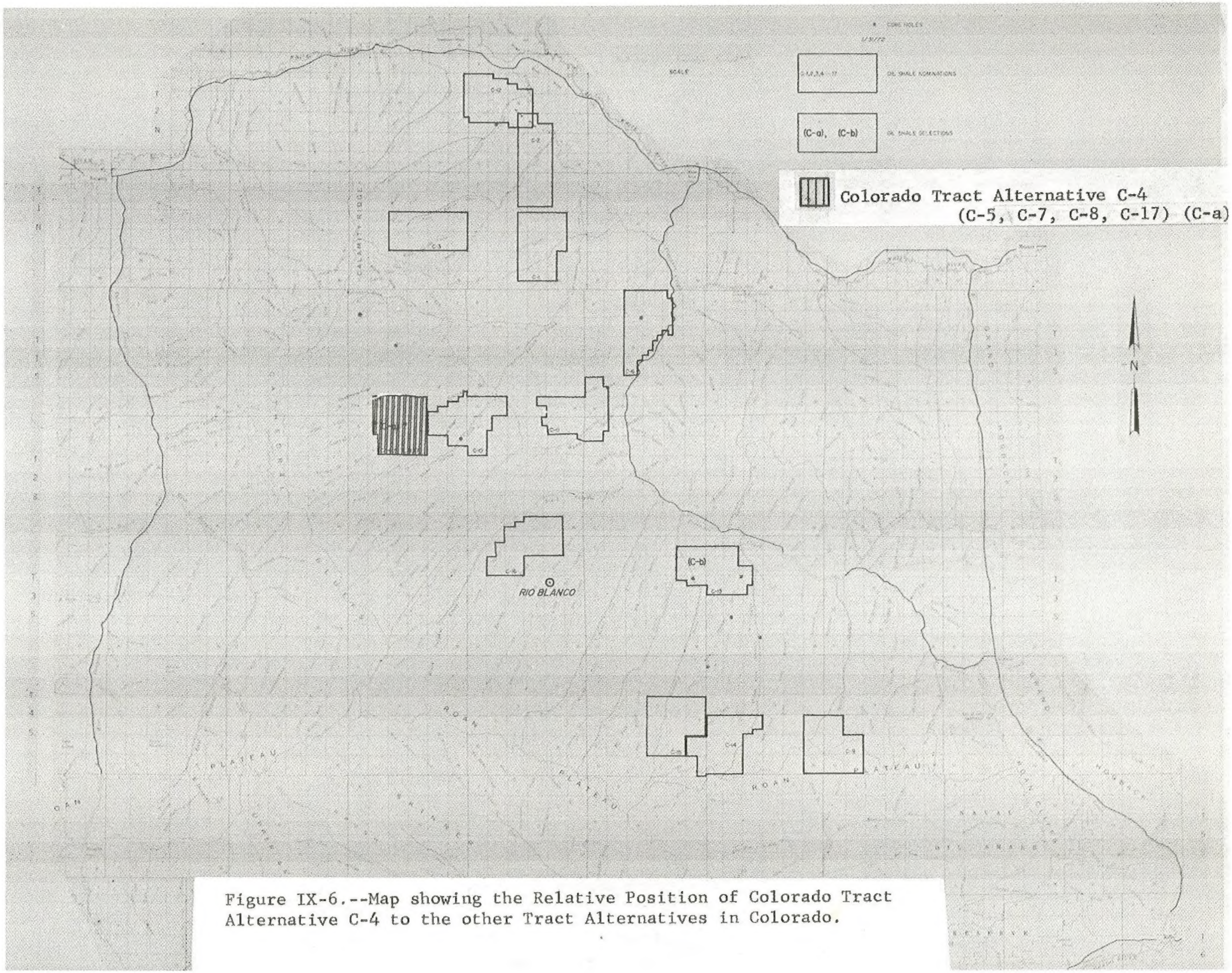

Figure IX-6.--Map showing the Relative Position of Colorado Tract Alternative C-4 to the other Tract Alternatives in Colorado.

Elevation. Tract elevation ranges from 6,700 feet to 7,300 feet above mean sea level.

Climate. Annual average rainfall is 15 to 18 inches. Annual temperature range is -40°F to +95°F.

Access. The most direct route to the center of this lease site is along Corral Gulch drainage from 84 Ranch for approximately 3.5 miles to the confluence with Box Elder Gulch, then on Box Elder Gulch for approximately 2 miles. These roads are being used at the present time and could be improved with minimum surface damage. The road from 84 Ranch through Ryan Gulch into Piceance Creek is a county maintained road. Total distance from the tract to Piceance Creek is approximately 16 miles.

Alternative access involves construction of new road to the Douglas Creek Valley, 10 airline miles to the west, then along existing county highway to Rangely.

Vegetative Type. Three major types of vegetative types in the area are sagebrush, pinyon-juniper and mountain browse.

Geologic Features:

(1) Alluvium. - Percent of the area is 10 to 15. Its composition consists of clay, silt, sand, marlstone fragments with a thickness of 0 to 100 feet.

(2) Evacuation Creek Member of the Green River Formation. - Percent of area, 75 percent. Its composition consists mostly of calcareous sandstone and siltstone with minor amounts of marlstone

Thickness ranges from 0 to 850 feet. Some zones contain a high percentage of analcime; extractable alumina may be present.

(3) Parachute Creek Member of the Green River Formation. - Percent of area, 100 percent. Its composition consists mostly of oil shale, minor amount of nahcolite and sandstone, thin beds of analcime, with a thickness of 1,500 feet.

(4) Structure. - A northwest trending graben fault bisects the area. The maximum measured vertical displacement is 175 feet. The rocks in general strike to the north and the dip is generally to the east and ranges from 400 feet per mile on the west to 300 feet per mile on the east.

(5) Hydrology. - Seven test wells were drilled on or near this tract. Water samples collected by the driller indicate that the electrical conductance of the water ranges from less than 1,000 umhos/cm to at least 1,400 umhos/cm in the upper zone and 2,000 umhos/cm to at least 20,000 umhos/cm in the lower zone. However, tests indicate that water from the upper zone is moving down the well bore into the lower zone indicating a lower head in the lower unit. Therefore, the quality of water in the lower zone may be more saline than that indicated by the water pumped from the well during the tests and while drilling.

Aquifer tests made by consultants in a well in sec. 4, T. 2 S., R. 99 W., indicate a transmissivity of 1,200 gpd/ft in the upper zone and a transmissivity of about 10,400 gpd/ft in the lower zone.

(6) Mineral Value:[1/]

(a) Mahogany Zone. - Contains about 60 feet of shale in

1/ Average approximately, but not less than 30 gallon/ton. Intervals greater than 10 feet thick and averaging less than 15 gallon/ton were not considered. This same criteria was used for all averaging of oil shale (gallon/ton) in this Statement.

units thicker than 10 feet that averages 30 gallons of oil per ton. The inplace shale oil resource is 120,000 barrels per acre.

(b) Lower Oil Shale Zones R-1 through R-6.: (See Figure II-35, Chapter II, Volume I). - About 435 feet of shale in units thicker than 10 feet average 30 gallons of oil per ton. The inplace shale oil resource is 880,000 barrels per acre. Nahcolite that is present probably occurs in pods. About 500 feet of section contains dawsonite in varying amounts.

Air and Water Quality Characteristics:

(1) Surface Water Quality. - The surface water quality in the area is generally fair to good.

(2) Air Quality. - Height suggests less problems with stagnation and inversion than lower sites through western location near Rangely. Prevailing winds from the southwest should reduce any problems which may have been caused by proximity to Rangely.

Transportation Network:

(1) Roads. - Existing roads are described under "Access." A jeep trail crosses the tract from the east to the west side in a northeast to southwest direction, connecting with a similar unimproved road to Calamity Ridge to the west.

(2) Pipelines. - Natural gas pipeline within one mile of site on southeast; 16-inch line.

Power Sources. - The nearest power source is at Stake Springs Draw, approximately 3 air miles southeast of the center of the lease area. The line could be constructed with little surface

damage if existing road rights-of-way are used. Telephone facilities are four miles southeast at Reagle Ranch.

Land Use.- Present land use consists of livestock grazing and wildlife habitat.

Vegetation and Soils. - The drainage bottoms are characterized by deep, light colored soils low in organic matter. These soils generally contain free salts in their profile and support stands of greasewood and other plants which can tolerate these salts. The ridges have a very shallow, light colored soil over sandstones and shales. There are large inclusions of deep, dark loam soils on the exposures suitable for development of deeper soils.

The shallow soils support stands of pinyon and juniper trees with a sparse understory of perennial grasses and various shrubs. The deeper soils support heavy stands of sagebrush with an understory of perennial grasses.

Plant Species:

(1) Browse

Amelanchier utahensis	Serviceberry
Purshia tridentata	Bitterbrush
Artemisia tridentata	Big sagebrush
Cercocarpus montanus	Mountain mahogany
Atriplex spp.	Saltbush
Chrysothamnus spp.	Rabbitbrush

(2) Grasses

Oryzopsis hymenoides	Indian ricegrass
Agropyron inerme	Beardless bluebunch wheatgrass
Koeleria cristata	Prairie junegrass
Poa spp.	Bluegrass
Elymus cinereus	Basin wildrye
Stipa comata	Needle and thread

(3) Trees

Pinus edulis	Pinyon pine
Juniperus osteosperma	Juniper
Quercus gambellii	Scrub oak

Vegetation Conditions.- Conditions are fair to good on vigor. The adaptability to revegetation is limited by shallow soils on ridges and slopes.

Wildlife.- Important upper winter use area for deer. Mule deer, wild horses, mountain lion, rabbits, coyotes, bobcats, raptors, doves, sage grouse, plus numerous small bird and mammal species exist on the tract.

This tract is situated in a relatively remote area having little agricultural or recreational activity and is managed by a state agency for primary benefit of wildlife species. This tract now constitutes a wildlife use area lying in the intermediate range zone. It also lies within wild horse migration routes from the summer areas to the southwest and the winter areas to the northeast.

Livestock Grazing.- Two operators use the tract for spring and summer cattle - 1,200 head 600 AUM's. The tract cuts normal migration route from winter-spring range to summer ranges. Area contains some stock watering facilities.

Improvements.- None of significance.

Archeology.- Entire basin is known to have been inhabited by the Ute Indians. However, no archeological finds are presently known or reported on tract.

Recreation and Esthetics. - Area is used primarily for hunting. Major recreation values are based upon wildlife use.

Environmental Impact of Development

This tract received five (5) separate site nominations and thus five (5) identifying numbers. It is Tract C-a in the proposal covered by this statement. Its environmental description outlined above is detailed in Chapter II and the environmental impact is described in Section A through G of Chapter IV. The impacts discussed for Tract C-a (C-4, 5, 7, 8, 17) in Chapter IV include: land, water, air, vegetation, wildlife and fish (fauna), recreation and esthetics, socioeconomic, specific cultural features, archeological and historical and grazing. This tract also overlays a portion of the Colorado State Department of Fish and Game Management Unit in the Basin. The only additional notation would be:

The oil shale resources of 30 gallons per ton in 10 feet of thickness or more would be 1,000,000 barrels per acre.

5. COLORADO TRACT ALTERNATIVE C-6

Description

Tract Alternative C-6.- This tract lies south of the White River and west of Piceance Creek (See Figure IX-7). Its legal description totals 5,018.10 acres and covers the following lands:

T. 1 S., R. 97 W., 6th P.M. Rio Blanco County, Colo.

Section: 2 - $S\frac{1}{2}$ Lot 3; Lot 4; $S\frac{1}{2}NW\frac{1}{4}$; $SW\frac{1}{4}$
3 - Lots 5, 6, 7, 8; $S\frac{1}{2}N\frac{1}{2}$, $S\frac{1}{2}$
4 - Lots 5, 6, 7, 8; $S\frac{1}{2}N\frac{1}{2}$; $S\frac{1}{2}$
9 - All
10 - All
11 - $NW\frac{1}{4}$; $E\frac{1}{2}SW\frac{1}{4}$; $NW\frac{1}{4}SW\frac{1}{4}$
15 - $NW\frac{1}{4}$; $NW\frac{1}{4}NE\frac{1}{4}$; $N\frac{1}{2}SW\frac{1}{4}$; $SW\frac{1}{4}SW\frac{1}{4}$
22 - $NW\frac{1}{4}NW\frac{1}{4}$
16 - All
21 - $NE\frac{1}{4}NE\frac{1}{4}$; $W\frac{1}{2}NE\frac{1}{4}$; $W\frac{1}{2}$

All of the tract is public domain except for the following: Sec. 2: $E\frac{1}{2}W\frac{1}{2}$ patented with Oil Shale reserved to the United States. Sec. 10: All except $SE\frac{1}{4}SE\frac{1}{4}$ patented with no minerals reserved. Sec. 11: $NW\frac{1}{4}$, $N\frac{1}{2}SW\frac{1}{4}$ patented with no minerals reserved. Sec. 15: $NW\frac{1}{4}NE\frac{1}{4}$, $NE\frac{1}{4}SW\frac{1}{4}$, patented with no minerals reserved and $NW\frac{1}{4}SW\frac{1}{4}$, $SW\frac{1}{4}NW\frac{1}{4}$ which is patented with Oil and Gas reserved to the United States. Sec. 21: $SW\frac{1}{4}NE\frac{1}{4}$, $NE\frac{1}{4}NE\frac{1}{4}$ patented with no minerals reserved to the United States. All public domain in Sections 15, 16 and 21 is covered by post-1920 placer claims.

Elevation. Tract elevation ranges from 6,100 feet to 6,500 feet above sea level.

Climate. Average annual rainfall is 15 to 17 inches. Annual temperature range is -40°F to +95°F. Approximate mean temperature is 45°F.

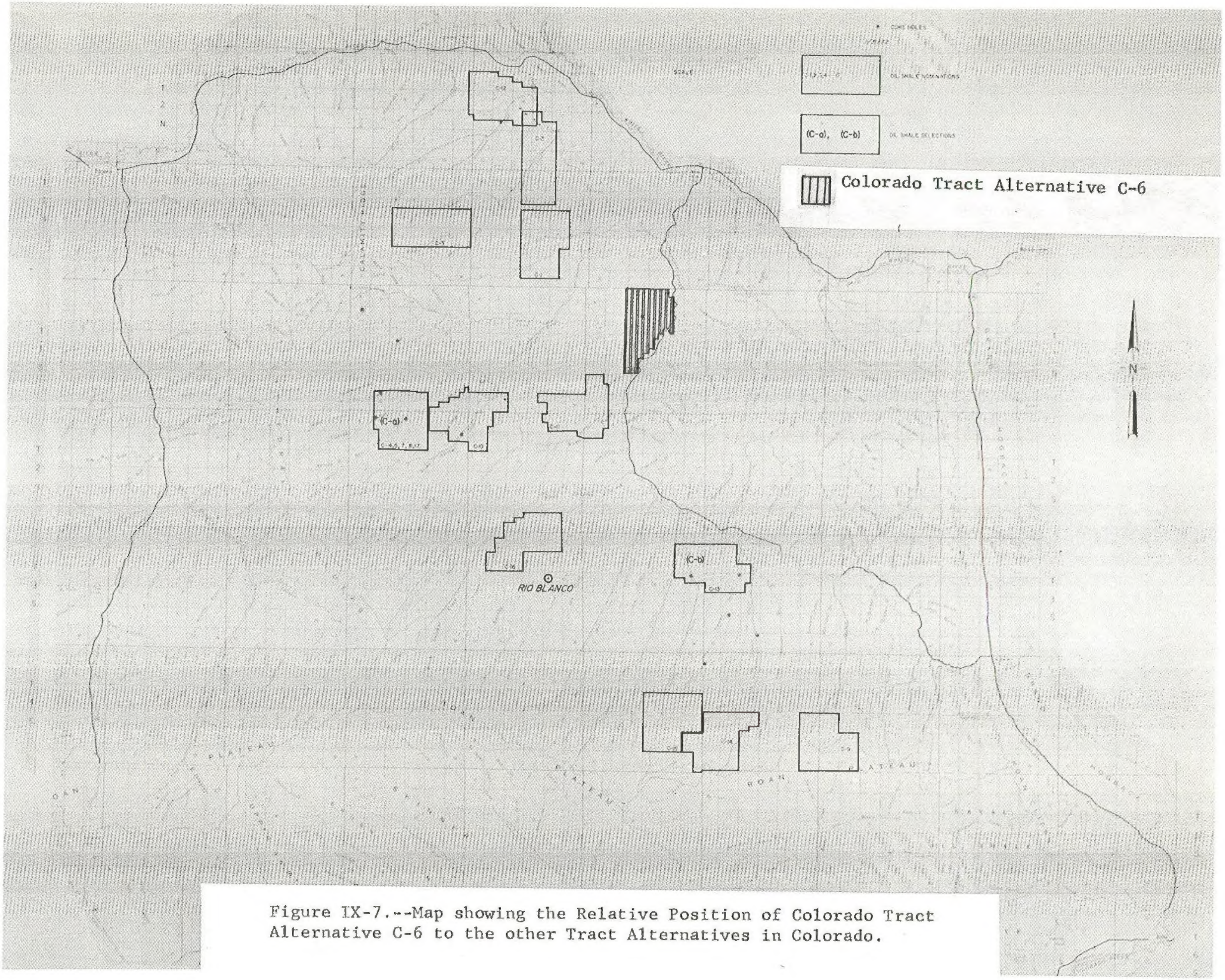

Figure IX-7.--Map showing the Relative Position of Colorado Tract Alternative C-6 to the other Tract Alternatives in Colorado.

Access. The most direct route to the center of Tract C-6 is from Piceance Creek approximately 2 miles to the east. An unimproved road provides access almost directly into the area from the Square S Ranch along Piceance Creek and can be upgraded without a great deal of surface disturbance. Access through private land would have to be obtained.

Vegetative Type. This tract is within the pinyon-juniper type. There are areas of big sagebrush, located in drainages. Mountain browse is interspersed throughout the area. Wheatgrasses, big sage, serviceberry and bitterbrush are the primary forage species.

Geologic Features:

(1) Alluvium.- Percent of area is 10 to 15 percent. Its composition consists of clay, silt, sand and marlstone fragments with a thickness of 0 to 200 feet.

(2) Evacuation Creek Member of the Green River Formation.- Percent of area, 100 percent. Its composition consists mostly of sandstone and siltstone with minor amounts of marlstone. Thickness ranges from 400 to 1,400 feet. Some units contain appreciable quantities of analcime; there may be some extractable alumina.

(3) Parachute Creek Member of the Green River Formation.- Percent of area, 100 percent. Its composition consists mostly of oil shale with minor amounts of bedded nahcolite and halite; and thin analcime beds.

(4) Structure. -No faults discovered in the tract. In the northern part of the tract, the oil shale trends to the east, and

in the southern part, it trends north-northeast. The dip in the northern part is to the north at the rate of 50 feet per mile. The dip in the southern part is to the north-northwest at the rate of 100 feet per mile.

(5) Hydrology.- A test hole drilled in Sec. 9, T. 1 S., R. 97 W., indicated a transmissivity of 1,300 gpd/ft in the upper zone and an electrical conductance of the water of 5,000 umhos/cm. In the lower zone, the electrical conductance of the water was 27,000 umhos/cm but the transmissivity was only 200 gpd/ft. There is a large amount of sodium chloride, 8,650 mg/l, present in the lower zone.

(6) Mineral Value:[1/]

(a) Mahogany Zone.-Contains about 100 feet of shale that averages 30 gallons of oil per ton in zones thicker than 10 feet. Inplace shale oil resource is approximately 200,000 barrels per acre.

(b) Lower Oil Shale Zones R-1 through R-6: (See Figure II-35, Chapter II, Volume I).- Contains about 500 feet of shale that averages 30 gallons of oil per ton in zones thicker than 10 feet. Inplace shale oil resource is approximately 1,000,000 barrels per acre. Bedded nahcolite and finely disseminated dawsonite in varying amounts are present in an oil shale sequence more than 700 feet thick. A zone about 500 feet thick extending downward from the lower part of the Mahogany Zone formerly contained nahcolite and halite but ground water has leached these saline minerals and

1/ Average approximately, but not less than 30 gallon/ton. Intervals greater than 10 feet thick and averaging less than 15 gallon/ton were not considered. This same criteria was used for all averaging of oil shale (gallon/ton) in this Statement.

highly saline water occupies the voids created by leachings.

Thick beds of halite occupy a great part of the 300-foot interval immediately underlying the leached zone. The leached zone and the zone containing halite may present difficult mining problems.

Air and Water Quality Characteristics:

(1) Surface Water Quality.- Surface water on the tract is essentially run-off of good quality.

(2) Air Quality.- Low, middle basin location places the tract in an area of probable night-time temperature inversions.

Transportation Network:

(1) Roads.-Existing roads are described under "Access".

(2) Pipelines.-None in the immediate vicinity.

Power Sources.- Electric power is available from a Federal line approximately 1.5 air miles southeast of the center of the tract. A telephone line is adjacent to this powerline.

Land Use.- Present land use consists of livestock grazing and wildlife habitat uses.

Vegetation and Soils.- The drainage bottoms are characterized by deep, light-colored soils low in organic matter. These soils generally contain free salts in their profile and support stands of greasewood and other plants which can tolerate these salts. The ridges have a very shallow, light-colored soil over sandstones and shales. There are large inclusions of deep, dark loam soils

on the exposures suitable for development of deeper soils.

The shallow soils support stands of pinyon and juniper trees with a sparse understory of perennial grasses and various shrubs. The deeper soils support heavy stands of sagebrush with an understory of perennial grasses.

Plant Species:

(1) Browse

Amelanchier utahensis	Serviceberry
Purshia tridentata	Bitterbrush
Artemisia tridentata	Big sagebrush
Cercocarpus montanus	Mountain mahogany
Atriplex spp.	Saltbush
Chrysothamnus spp.	Rabbitbrush

(2) Grasses

Oryzopsis hymenoides	Indian ricegrass
Agropyron inerme	Beardless bluebunch wheatgrass
Koeleria cristata	Prairie junegrass
Poa spp.	Bluegrass
Elymus cinereus	Basin wildrye
Stipa comata	Needle and thread

(3) Trees

Pinus edulis	Pinyon pine
Juniperus osteosperma	Juniper
Quercus gambellii	Scrub oak

Vegetation Conditions.- Fair to good on vigor. Tract adaptability to revegetation is limited by shallow soils on ridges and slopes.

Wildlife.- Mule deer are numerous particularly in the winter, as are mountain lion, coyote, bobcat, chuckar, doves, rabbits, raptors, in addition to numerous small bird and mammal species. Although situated adjacent to a surfaced highway, the tract is minimally affected by agricultural or industrial activity. It lies in close proximity to the Piceance Creek. This tract receives

wild horse use during the winter months.

Livestock Grazing.- One operator has 1,000 head of cattle grazing on the tract during the spring and fall each year - 500 AUM's are available per year.

Improvements.- No significant improvements are on this tract. The Square S AMP 1/ calls for a pasture fence through this area but the plan could undoubtedly be adjusted to allow moving the fence off of the tract.

Archeology.- None known or reported on tract, however, it is known that the entire basin was once inhabited by the Ute Indians.

Recreation and Esthetics.- Area is used primarily for hunting and major values are wildlife.

Environmental Impact of Development

Development by underground mining, the method for which the tract appears best suited, would probably have the following impacts upon the environment:

Water.- The impact on water supply and water quality should be about the same as that described for Tract C-b. The nearness of Piceance Creek, which flows through one corner of the tract, and the potential for waste disposal across the creek in numerous adjacent canyons, increases the probability of some additional impact on surface water quality from construction-caused sedimentation.

Additional affects associated with mine water disposal could also be encountered but are uncertain. Surface water drainage through fractured rock structure, if it occurred, would increase the mine water disposal and associated affects.

1/ Allotment Management Plan

<u>Land</u>.- The impact on land would be expected to be similar to that described for Tract C-b. The topography is similar and drainage is into Piceance Creek in both cases.

<u>Air</u>.- The impact on air quality would be expected to be similar to that anticipated for Tract C-13 development, although there is a possibility it may be greater. An additional factor could be the potential for greater on-site hazards during temperature inversion periods due to the valley location, lower elevation and more moderate local climatic conditions.

<u>Wildlife</u>.- This tract is located in critical winter mule deer range. Important deer migration routes transect this tract and would be interrupted by tract development. The effect of industrial penetration of habitat areas is moderated by the fact that the tract is located adjacent to a surfaced highway. Downstream fish resources could be reduced by accelerated erosion and increased sediment load. Wild horse use of the range in this tract is heavy during winter and moderate impact could be expected from development forcing the herd north and west into higher elevations for winter forage. This tract also overlays a portion of the Colorado State Department of Fish and Game Wildlife Management Unit in the Basin.

<u>Vegetation</u>.- The impact on vegetation would be expected to be similar to that indicated for Tract C-b.

<u>Grazing</u>.- A portion of one grazing allotment would be affected by tract development. One thousand (1,000) head of cattle utilizing about 500 AUM's in spring and fall each year would be required to graze elsewhere. One operator and his business would be affected.

Recreation.- The impact on recreation would be severe in terms of hunting use. The tract now receives heavy hunter use annually, and is easily accessible to the public from paved roads and connecting trails. Hunting use would decline as the tract was developed and big game animals dispersed and reduced in population.

Cultural Features.- No impact on cultural features is expected, except for the likelihood of new road and bridge connections to the Piceance Creek Road. One jeep road from southeast to northwest through the tract, now utilized by the public could be closed if it interfered with mine operations.

Minerals.- The impact on mineral development and ancillary industry would be similar to that expected for Tract C-1. Oil shale resources that would be affected by development approximate 1,200 thousand barrels per acre.

Archeological and Historical.- No evidence to indicate any effect should be anticipated, however, as the Ute Indians are known to have existed in this area, the possibility exists of impact on artifacts.

Socioeconomic.- The impact would be expected to be similar to that anticipated from development of Tract C-b.

6. COLORADO ALTERNATIVE TRACT C-9

Description

Alternative Tract C-9.-This tract lies in the southeastern part of the Piceance Creek Basin just north of the Roan Plateau (See Figure IX-8). Its legal description given below includes lands which total 5,128.14 acres:

T. 4 S., R. 95 W., 6th P.M., Garfield Co., Colo.

Sections: 19 - All
29 - All
30 - All
31 - All
32 - All

T. 4 S., R. 96 W., 6th P.M., Garfield Co., Colo.

Sections: 24 - All
25 - All
36 - All

The tract is all unappropriated public domain except: Sec. 36: SE¼ patented with oil and gas reserved to the United States. Sec. 31: SE¼ Withdrawal-Public Water Reserve. The entire tract is covered by a mineral entry Patent Application C-09072. The entire tract except for SE¼ of Sec. 36, T. 4 S., R. 96 W. is covered by pre-1920 placer mining claims. The entire tract is also covered by post-1920 mining claims except for the above exclusion and Sec. 24, T. 4 S., R. 96 W. and Sec. 19, T. 4 S., R. 95 W. is covered by pre-1920 placer mining claims.

Elevation.-Tract elevation ranges from 7,500 feet to 8,300 feet.

Climate.-Average annual rainfall is 20 to 25 inches. Annual temperature range is -40°F to +95°F. Approximate mean temperature is 45°F.

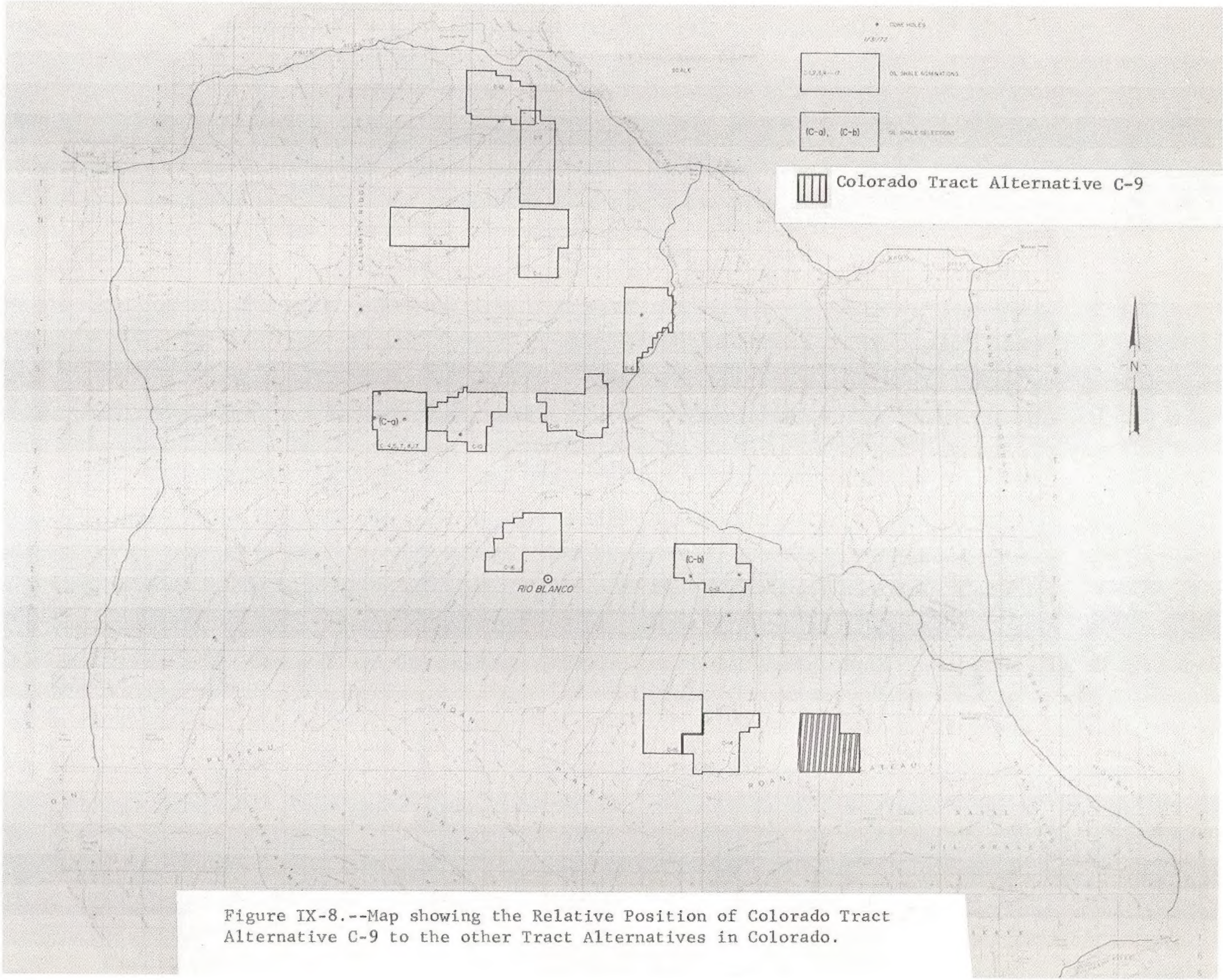

Figure IX-8.--Map showing the Relative Position of Colorado Tract Alternative C-9 to the other Tract Alternatives in Colorado.

Access.-Access to Tract C-9 is most readily available from Piceance Creek approximately 8.5 miles north of the center of the tract along the Sprague Gulch Road - BLM No. 1112. The road is unimproved but the alignment is fair and can be easily upgraded.

Vegetative Type.-Mountain browse.

Geologic Features:

(1) Alluvium.- Percent of area is 5 percent. Its composition consists of clay, silt, sand and marlstone fragments with a thickness of 0 to 50 feet.

(2) Evacuation Creek Member of the Green River Formation.- Percent of area, 90 percent. Its composition consists mostly of sandstone and siltstone with minor amounts of marlstone and low-grade oil shale. Thickness ranges from 0 to 800 feet. Some units contain appreciable quantities of analcime; there may be some extractable alumina.

(3) Parachute Creek Member of the Green River Formation.- Percent of area, 100 percent. It consists mostly of oil shale of 1,000 to 1,200 feet thick with some thin beds of sandstone and analcime and minor amounts of nahcolite.

(4) Structure.- No faults apparent. The rocks strike generally to the west and the dip is about 200 feet to the mile to the north.

(5) Hydrology.- No hydrologic data are available for this tract. However, considering its topographic position and its relatively great distance from the center of the basin where ground water is highly mineralized, it is likely that quality of ground water is good and that the quantity of ground water in the upper zone is small (no consideration was given to the lower zone).

(6) Mineral Value: 1/

(a) Mahogany Zone.-Contains 100 to 130 feet of oil shale that averages 30 gallons of oil per ton in zones thicker than 10 feet, with an in-place resource of 200 to 260 thousand barrels of shale oil per acre.

(b) Lower Oil Shale Zones (R-1 through R-6): (See Figure II-35, Chapter II, Volume I).-The lower three zones probably are not present and the remaining three are poorly developed. There probably is no shale averaging 30 gallons of oil per ton in units thicker than 10 feet. The amount of nahcolite is insignificant and probably less than 100 feet of shale contains dawsonite in significant quantities.

Air and Water Quality Characteristics:

(1) Surface Water Quality.-Surface waters are essentially good quality runoff waters.

(2) Air Quality.-High elevation lessens the possibility of stagnation or inversion if gaseous emissions occur on the tract. The tract is closest to Rifle, but prevailing winds should direct emissions to the northeast. If extensive operations were begun in the Parachute Creek Valley, drainage winds might affect Grand Valley.

Transportation Network:

(1) Roads.-Existing roads are described under "Access."

(2) Pipelines.-None in the immediate vicinity.

1/ Average approximately, but not less than 30 gallons/ton. Intervals greater than 10 feet thick and averaging less than 15 gallons/ton were not considered. This same criteria was used for all averaging of oil shale (gallon/ton) in this statement.

Power Sources.- Electric power is available from the power line in the Piceance Creek Basin and the power line to the tract could easily follow the same alignment as the road. Telephone lines are adjacent to this powerline.

Land Use.- Present land use consists of livestock grazing and wildlife habitat uses.

Vegetation and Soils.- Soils are generally deeper, 20 to 36 inches, than in the tracts located northwest of this area. Soils are also darker and more fertile.

Plant Species:

(1) Browse

Amelanchier utahensis	Service berry
Symphoricarpos tetonensis	Snow berry
Purshia tridentata	Bitterbrush
Cercocarpus montanus	Mountain mahogany
Artemisia tridentata	Big sagebrush

(2) Grasses

Agropyron inerme	Beardless bluebunch wheatgrass
Poa spp.	Bluegrass
Stripa spp.	Stipa
Oryzopsis hymenoides	Indian ricegrass
Elymus cinereus	Basin wildrye
Bromus carinatus	Mountain brome

(3) Trees

Pinus edulis	Pinyon pine
Juniperus osteosperma	Juniper
Populus tremuloides	Aspen
Pseudotsuga menziesii	Douglas-fir
Quercus gambellii	Scrub oak

Vegetation Conditions.- Fair to good on vigor. Revegetation is limited by shallow soils on ridges and slopes.

Wildlife.- The tract serves as a spring, summer and fall deer range and receives some utilization as elk winter range.

Deer, elk, bear, coyote, mountain lion, bobcat, blue grouse,

sage grouse, rabbits, raptors, as well as numerous small bird and mammal species exist on the tract.

Livestock Grazing.- Cattle and sheep graze this tract during the summer months. During the spring and fall months, the livestock are offsite to the north.

There are 4,077 cattle and 4,124 sheep licensed to graze within the areas covered by these tracts. Approximately 600 AUM's are produced on this tract.

Improvements.- None of any significance.

Archeology.- None known or reported on tract.

Recreation and Esthetics. - Area is used primarily for hunting and major values are wildlife.

Environmental Impact of Development

Development by underground mining methods, which appears feasible for this tract, would probably have the following impacts on the environment:

Water.- The expected impact on water supply and water quality would be approximately similar to that described for development of Tract C-b. The streams that could be affected are in the headwaters of Piceance Creek, draining to the north, and Parachute Creek, draining to the south.

Effects on headwaters flow ultimately could reach Stuart Creek, Story Creek, and Middle Parachute Creek. Less mine dewatering and disposal would be involved due to the high potentiometric contour of the ground crater. This would lessen potential water quality

impacts from disposal and increase surface water supply requirements over those for Tract C-b.

Land.- The impact would be expected to be similar to those described for Tract C-b. The canyons involved in waste disposal could be: Harrison Gulch, Story Gulch, Stewart Gulch, Spring Gulch, Schutle Gulch, McCarthy Gulch and Upper Parachute Creek. Erosion hazards would be high due to high rainfall and steep slopes which are characteristic of the tract.

Air.- The impact on air quality should be less than that described for Tract C-b, except that inversions, air drainage, and prevailing winds would carry effects in the direction of Grand Valley and Rifle. Grand Hogback and the Roan Cliffs to the east of this tract are higher in elevation and could have a cumulative blocking effect over time on eastward air movement against the west facing slopes which are timbered. An increase in adverse effects on vegetation could result.

Wildlife.- The area is outside of the critical winter deer range; however it does provide elk summer and winter range, bear habitat, mountain lion habitat and summer mule-deer range and sage and blue grouse habitat. The total wildlife population on the tract would be reduced.

Other wildlife effects would be similar to those expected for Tract C-b. No wild horses would be affected. Priority wildlife management as an intensive management unit is not associated with this tract due to its altitude and thus would not be affected except that access to this area would be through winter deer range.

Vegetation.- The impact expected would be similar to that described for Tract C-b with the possible additional effect noted above and the loss of some pine trees along the streams and canyons.

Grazing.- The impact would be upon (1) livestock operators and (2) livestock and sheep operators. An entire sheep operation (4,124 sheep) is on the tract. The cattle are on this tract and adjoining areas (4,077 head). Both would need to be moved or operations reduced significantly. Operator income would be lowered if substitute range could not be found. Approximately 600 AUM's produced on the tract might be lost.

Recreation.- One primitive unimproved road (Divide Road) through the tract traverses the high ground and is under consideration for designation as a scenic road. It would be interrupted by tract development and aesthetic values reduced. Penetration of the high plateau area by industrial development would affect the scenic unity the area possesses.

Cultural Features.- Vegetative conversions planned by BLM for the tract would be modified. Approximately 2,500 acres could be lost from approved development plans and the control program in this area affected. The area is a valuable watershed area.

Minerals.- The impact would be expected to be similar to that described for Tract C-b except less rich shale deposits are involved and little nahcolite and dawsonite. C-9 Tract development could

influence rate of development of the Naval Oil Reserve south and southeast of tract. Oil shale resources that would be affected by tract development approximate 230 thousand barrels per acre.

Archeological and Historical.- No evidence to indicate any effect should be anticipated, however, as the Ute Indians did once exist in the basin, the possibility of some impact on artifacts does exist.

Socioeconomic.- The impact would be expected to be similar to that described for Tract C-b.

7. COLORADO TRACT ALTERNATIVE C-10

Description

Tract Alternative C-10.- This tract lies east of Tract C-a (See Figure X-9). Its legal description covers the following lands which total 5,126.06:

<u>T. 1 S., R. 99 W., 6th P.M., Rio Blanco Co., Colo.</u>

Sections: 25 - $SE\frac{1}{4}SE\frac{1}{4}$
35 - $SE\frac{1}{4}$, $S\frac{1}{2}SW\frac{1}{4}$
36 - $S\frac{1}{2}$, $S\frac{1}{2}NW\frac{1}{4}$, $NE\frac{1}{4}$

<u>T. 2 S., R. 99 W., 6th P.M., Rio Blanco Co., Colo.</u>

Sections: 1 - All
2 - All
12 - $N\frac{1}{2}$

<u>T. 1 S., R. 98 W., 6th P.M., Rio Blanco Co., Colo.</u>

Sections: 31 - All
32 - All

<u>T. 2 S., R. 98 W., 6th P.M., Rio Blanco Co., Colo.</u>

Sections: 5 - $W\frac{1}{2}NW\frac{1}{4}$, $NW\frac{1}{4}SW\frac{1}{4}$
6 - All
7 - All

All of the tract is public domain except for the following: T. 1 S., R. 98 W., Sec. 31: $S\frac{1}{2}SE\frac{1}{4}$, $NE\frac{1}{4}SE\frac{1}{4}$, $SE\frac{1}{4}NE\frac{1}{4}$ patented with oil shale reserved to the United States. Sec. 32: $N\frac{1}{2}NW\frac{1}{4}$, $SW\frac{1}{4}NW\frac{1}{4}$, $NW\frac{1}{4}SW\frac{1}{4}$ patented with oil shale reserved to the United States. T. 2 S., R. 98 W., Sec. 6: $W\frac{1}{2}SW\frac{1}{4}$ patented with all minerals reserved to the United States. T. 2 S., R. 99 W., Sec. 7: $W\frac{1}{2}NW\frac{1}{4}$ patented with all minerals reserved to the United States. Sec. 1: $SE\frac{1}{4}SE\frac{1}{4}$ patented with oil shale reserved to the United States. Sec. 12: $NE\frac{1}{4}$ patented with oil shale reserved to the United States. The following lands, T. 2 S., R. 99 W., Sec. 1: $N\frac{1}{2}$, $SW\frac{1}{4}$; Sec. 2: All; T. 1 S., R. 98 W., Sec. 31 and 32 covered by post-1920 placer claims.

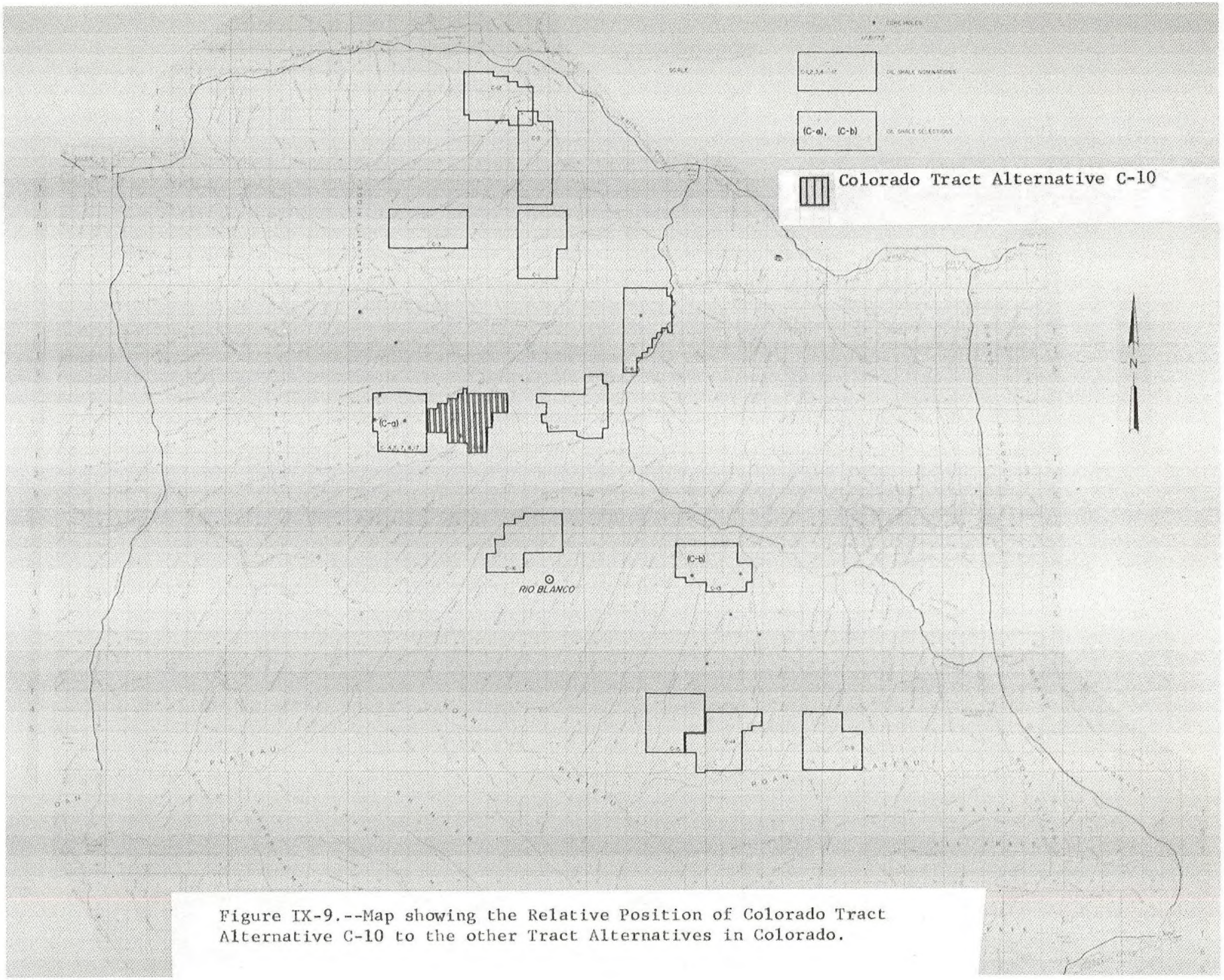

Figure IX-9.--Map showing the Relative Position of Colorado Tract Alternative C-10 to the other Tract Alternatives in Colorado.

Elevation. Tract elevation ranges from 6,500 to 7,000 feet above sea level.

Climate. Average annual rainfall is 15 to 17 inches. Annual temperature range is -40°F to +95°F. Approximate mean temperature is 45°F.

Access. The most direct route to the center of this tract is from 84 Ranch along Stakes Springs Draw drainage for approximately 2 miles. The route from 84 Ranch through Ryan Gulch to Piceance Creek, approximately 11 miles, is county road. All present roads could be easily upgraded in their present alignment.

Vegetative Type. Pinyon, juniper, and sagebrush are the major vegetative types in this area.

Geologic Features:

(1) Alluvium.-Percent of area is 5 to 10 percent. Its composition consists of clay, silt, sand and marlstone fragments with a thickness of 0 to 150 feet.

(2) Evacuation Creek Member of the Green River Formation.-Percent of area, 100 percent. Its composition consists mostly of calcareous sandstone and siltstone with minor amounts of marlstone. Thickness ranges from 500 to 1,050 feet. Some zones contain a high percent of analcime; extractable alumina may be present.

(3) Parachute Creek Member of the Green River Formation.-Percent of area, 100 percent. It consists mostly of oil shale 1,500 feet + thick, some thin sandstone and analcine beds, very small amounts of nahcolite.

(4) Structure.-Possibly a few normal faults of slight displacement in the southwest part of the tract. The rocks strike generally to the northwest and the dip is generally to the northeast at the rate of 100 to 150 feet per mile.

(5) Hydrology.-Water data are available from a test hole drilled in Sec. 12, T. 2 S., R. 99 W. In the upper zone, the electrical conductance of the water is 2,200 umhos/cm and the transmissivity is 12,000 gpd/ft. In the lower zone the conductance reached 5,000 umhos/cm and the transmissivity 10,000 gpd/ft.

(6) Mineral Value: 1/

(a) Mahogany Zone.-Contains approximately 70 feet of shale averaging 30 gallons of oil per ton in units thicker than 10 feet with an in place resource of 140,000 barrels per acre.

(b) Lower Oil Shale Zones R-1 through R-6: (See Figure II-35, Chapter II, Volume I).-About 700 feet of oil shale average 30 gallons of oil per ton in units thicker than 10 feet with an in place resource of 1,400,000 barrels per acre. About 600 feet of section contains finely disseminated dawsonite in varying amounts.

About 800 to 900 feet of section that formerly contained saline minerals has been leached by ground water and the voids created by the leaching are now filled with moderately saline water. This could present difficult mining problems in the lower zone.

Air and Water Quality Characteristics:

(1) Surface Water Quality.-Surface water in the area is of fair quality.

1/ Average approximately, but not less than 30 gallons/ton. Intervals greater than 10 feet thick and averaging less than 15 gallons/ton were not considered. This same criteria was used for all averaging of oil shale (gallon/ton) in this statement.

(2) Air Quality.-The tract's moderate elevation position along flank of basin may result in concentrated discharges because of nighttime drainage winds. General inversion conditions would be similar to those on Tracts C-a and C-11.

Transportation Network:

(1) Roads.-Existing roads are described under "Access".

(2) Pipelines.-Cascade 16-inch natural gas line cuts the southern portion of the area.

Power Sources.-Electric power is available on the tract. Telephone facilities are located 4 miles southeast.

Land Use.- Present land use consists of livestock grazing and wildlife habitat.

Vegetation and Soils.-The drainage bottoms are characterized by deep, light-colored soils low in organic matter. These soils generally contain free salts in their profile and support stands of greasewood and other plants which can tolerate these salts. The ridges have a very shallow, light-colored soil over sandstones and shales. There are large inclusions of deep, dark loam soils on the exposures suitable for development of deeper soils.

The shallow soils support stands of pinyon and juniper trees with a sparse understory of perennial grasses and various shrubs. The deeper soils support heavy stands of sagebrush with an understory of perennial grasses.

Plant Species:

(1) Browse

Amelanchier utahensis	Serviceberry

(1) Browse (cont'd)	
Purshia tridentata	Bitterbrush
Artemisia tridentata	Big sagebrush
Cercocarpus montanus	Mountain mahogany
Atriplex spp.	Saltbush
Chrysothamnus spp.	Rabbitbrush
(2) Grasses	
Oryzopsis hymenoides	Indian ricegrass
Agropyron inerme	Beardless bluebunch wheatgrass
Koeleria cristata	Prairie junegrass
Poa spp.	Bluegrass
Elymus cinereus	Basin wildrye
Stipa comata	Needle and thread
(3) Trees	
Pinus edulis	Pinyon pine
Juniperus osteosperma	Juniper
Quercus gambellii	Scrub oak

Wildlife.- This tract is an important mule deer winter-range area, lying within prime elevational zone. It is also inhabited by deer, mountain lion, coyote, bobcat, sage grouse, raptors, doves, rabbits and numerous small bird and mammal species. The primary wildlife value of this tract is that it lies in the heart of a wildlife habitat area primarily managed by a State agency for the benefit of wildlife uses. This tract also lies in the intermediate horse range zone and cuts across migration routes from the summer areas to the southwest and winter areas to the northeast. The tract is remote from population centers and is subject to little industrial activity.

Livestock Grazing.- Two operators use the tract for spring and summer cattle - 1,200 head, 600 AUM's. The tract lies within normal migration route from winter-spring range to summer ranges. It also contains some stock watering facilities.

Improvements.- None of significance in the vicinity.

Archeology.- None known are reported on the tract.

Recreation and Aesthetics.- Area is used primarily for hunting and major values are wildlife.

Environmental Impact of Development

This tract is considered to offer opportunities for surface mining, underground mining or in-situ operations. If developed with surface methods, the general effects would be expected to follow the general pattern of impacts associated with development of Tract C-a. If the method is underground mining, the impact pattern in general would probably approach that described in Tract C-b, with differences due to site location. An in-situ operation or a combination underground and in-situ operation (which is in situ with limited underground mining) would be expected to approach those impacts described for W-a, also with differences due to location.

Surface mine development would likely lead to the following environmental impacts:

Water.- The effect should be greater than that described for Tract C-a due to larger pit development. Stake Springs Creek, and tributaries and Box Elder Creek and tributaries would be affected. Yellow Creek which flows through the tract, and Stake Springs would cease to exist in the vicinity of the tract.

Land.- The expected impact on land should be greater than estimated for Tract C-a due to a greater thickness of overburden (900 feet for C-10 versus 450 feet for C-a) and oil shale (770 feet for C-10 versus 500 feet for C-a) each of which would require disposal. One road through the tract along Stake Springs Creek Gulch and a portion

of another road cuts through the NE corner, both are primitive and unimproved roads. These could be altered or closed. Canyons in that vicinity that could possibly be utilized for waste disposal include areas to the northeast, south, and southwest or west of Cathedral Bluffs. Their topography and drainage would be changed. Cascade Natural Gas pipeline cuts south portions of the area and could conflict with some operations unless carefully planned co-ordination takes place.

Air.- The impact on air quality should be about as described for Tract C-a.

Wildlife.- This tract is a more critical winter range than C-a for mule deer, lying within the prime elevation zones. It is about on the edge of the good winter deer range. It is a significant area in the basin for wild horses and cuts across wild horse and mule deer migration routes and is utilized by deer in their migration. The impact will be localized loss of important deer winter-range habitat, disruption of game and wild horse migration and industrial penetration into a State managed wildlife habitat area, with affects on that program.

Vegetation.- Approximately 65% of the area is in good soils for vegetation growth. About 25% is pinyon-juniper. Effects on the vegetative cover types existing should be somewhat greater than those described for Tract C-a due to the larger land requirements for disposal operations.

Grazing.- The movement of cattle from summer to winter range across this tract would be interrupted and diverted. About 1,411 cattle graze

the area. About 600 AUM's of forage harvested in spring and summer would be lost. Three livestock operators would be involved.

Recreation.- The tract receives heavy use by sportsmen during deer season. Existing unimproved roads are used seasonally by recreationists generally. Hunting use would become reduced, particularly over the long term. Recreation impact otherwise would be approximately as described for Tract C-a.

Cultural Features.- It is likely that the unimproved road from Stake Springs, the southwest through Cathedral Bluffs and to Yellow Creek on the north probably would be upgraded (to Piceance Creek and the county road). Access to the high county through the tract from the north could become blocked if operations interfered with public use of the road.

Minerals.- Nahcolite is not significantly indicated as a resource on this tract. Dawsonite resources exist and could be removed. The impact on shale resources would be significantly larger than on Tract C-a because of the greater amount of resource that is available. The resources that would be affected average 1,540 thousand barrels per acre.

Archeological and Historical.- No evidence to indicate any significant effect should be anticipated. However, as the Ute Indians did once inhabit the region, some impact on artifacts may occur.

Socioeconomics.- The expected impact should be similar to that for Tract C-a.

If this tract was developed by underground mining, the differences in impact that would be likely are highlighted below. Many impacts would be indistinguishable between surface mine and underground development.

Water.- The water features described above would likely be affected: Coral Gulch, Stake Springs, Stake Springs Creek, Box Elder Creek and tributaries, and Yellow Creek. The magnitude of impacts would more nearly resemble those described for Tract C-b, however.

Land.- Underground mining would disturb less surface area than would surface development. The same topography and roads would be involved. A road along Stake Springs Gulch through the trail and another through the northeast corner could be altered or closed. Fewer canyons would be used for waste disposal with an underground mine. The magnitude of impacts would approximate that described for Tract C-b. Locations affected would likely be those immediately peripheral to the tract.

Air.- The impact on air quality should be about as described for Tract C-a, but at about one-half the ambient emission levels that would occur with a larger plant which might occur under a surface mining option.

Wildlife.- The expected impact on wildlife would be less than estimated above for surface mine development of the same tract due to smaller requirements for land. However, such development would result in loss of important winter deer habitat, disruption of deer migration and wild horse migration, conflict with the State wildlife management operating area and penetration by industry and traffic of a remote area on the Piceance plateau.

Vegetation.- About 65 percent of the tract is covered with good soils and about 25 percent is covered with pinyon-juniper. Any differences in effect on vegetation would be due to the extent of vegetative disturbance. This would approximate levels estimated for Tract C-b.

Grazing.- Effects would involve the same three operators and 600 AUM's described for the surface development option on this tract. About 1,411 cattle graze the area.

Recreation.- The major recreational effect would be upon hunting, particularly big game hunting. Hunting use would be reduced over the long term. Existing unimproved roads traversing the tract are travel ways for hunters and could become blocked from use. Other recreational effects would be about as described for Tract C-a.

Cultural Features.- It is likely that the unimproved road from Stake Springs and Cathedral Bluffs southwest through the tract to Yellow Creek would become upgraded at least to the tract vicinity. Access to the high country through the tract could become blocked if mining operations interferred with public use of the road.

Minerals.- The impact on mineral resources would likely be about as described above. Oil shale resources of 30 gallon per ton that would be affected average 1,540 thousand barrels per acre.

Archeological and Historical.- The same effect would be expected as described above for surface mine development of this tract.

Socioeconomic.- The expected impact would be similar to that described for Tract C-a. However, it would be somewhat less due to the lower level of oil production if the underground method was used.

8. COLORADO TRACT ALTERNATIVE C-11

Description

This tract lies about 8 miles east of Tract C-a and 1 mile west of Piceance Creek. (See Figure IX-10). The tract contains 5,118.08 acres in Colorado. The legal description is as follows:

T. 1 S., R. 97 W., 6th P.M., Rio Blanco Co., Colo.

Sections: 29 - W½SW¼
30 - Lots 1, 2, 3 and 4, E½W½, E½
31 - Lots 1, 2, 3 and 4, E½W½, E½
32 - W½W½

T. 1 S., R. 98 W., 6th P.M., Rio Blanco Co., Colo.

Sections: 34 - NE¼
35 - All
36 - All

T. 2 S., R. 97 W., 6th P.M., Rio Blanco Co., Colo.

Sections: 5 - Lot 4, SW¼NW¼; NW¼SW¼
6 - Lots 1 through 7, inclusive, SE¼NW¼; S½NE¼; E½SW¼; SE¼
7 - Lot 1, NE¼NW¼; N½NE¼

T. 2 S., R. 98 W., 6th P.M., Rio Blanco Co., Colo.

Sections: 1 - Lots 5 through 20, inclusive
2 - Lots 5 through 20, inclusive
3 - Lots 5 and 6
12 - Lots 1 and 2

The entire tract is public domain. T. 2 S., R. 98 W., Sec. 1: Lot 10 is covered by Public Water Reserve 107. Sec. 2: Lot 15 is covered by Public Water Reserve 107.

Lands described as T. 1 S., R. 97 W., Sec. 29: W½SW¼, Sec. 30: All T. 1. S., R. 92 W., Sec. 34: NE¼ are covered by post-1920 mining claims.

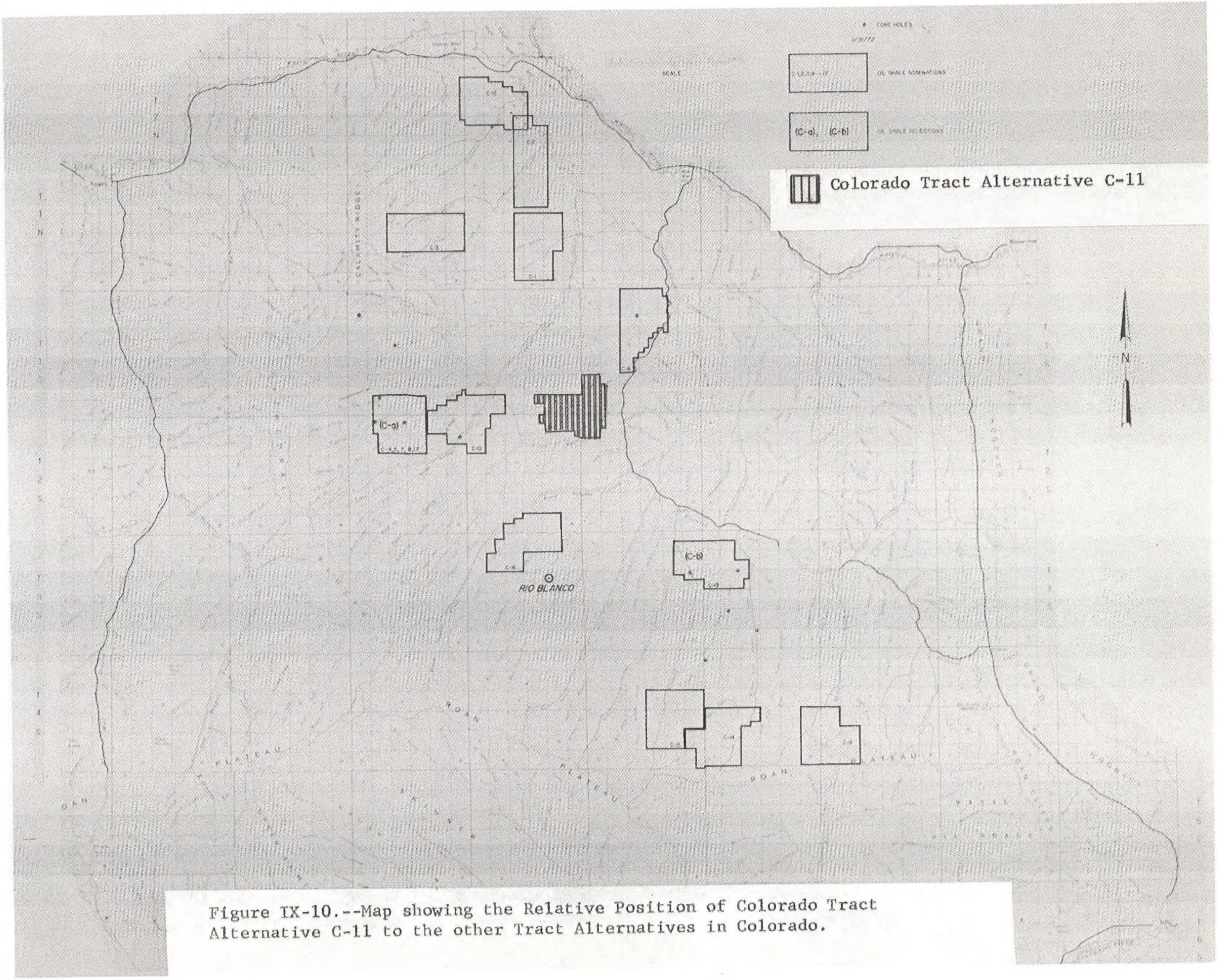

Figure IX-10.--Map showing the Relative Position of Colorado Tract Alternative C-11 to the other Tract Alternatives in Colorado.

Elevation.- Tract elevation ranges from 6,200 feet to 6,700 feet above mean sea level.

Climate.- Average annual rainfall is 15 to 17 inches. Annual temperature range is -40°F to +95°F. Approximate mean temperature is 45°F.

Access.- Access is readily available through a county road along the drainage of Ryan Gulch for approximately 2 miles. A mile of new road will have to be constructed to allow access to the center of the tract.

Vegetative Type.- This tract is within the pinyon-juniper type. There are areas of big sagebrush, located in drainages. Mountain browse is interspersed throughout the area. Wheatgrasses, big sage, serviceberry and bitterbrush are the primary forage species.

Geologic Features:

(1) Alluvium.- Percent of area, 10 to 15 percent. Its composition consists of clay, silt, sand, and marlstone fragments, with a thickness of 0 to 200 feet ±.

(2) Evacuation Creek Member of the Green River Formation.- Percent of area, 100 percent. Composition consists mostly of sandstone and siltstone with minor amounts of marlstone and low grade oil shale. It has a thickness of 500 to 1,100 feet. Some zones contain appreciable quantities of analcime; extractable alumina may be present.

(3) Parachute Creek Member of the Green River Formation.- Percent of area, 100 percent. Composition consists mostly of oil shale with some some sandstone and siltstone beds and thin beds of halite and nahcolite. It has a thickness of 1,500 feet ±.

(4) Structure.- A graben with relatively small displacement trending northwest is in the southeastern portion of the tract. The rocks trend north in the eastern part of the tract and northwest in

the western part. The dip is west in the eastern part of the tract at the rate of 150 feet per mile and is northeast in the western part at the rate of 150 feet per mile.

(5) Hydrology.- Water data are available from a test hole drilled in Section 2, T.25., R. 98W. Test results indicate that, for the upper zone, the specific conductance is 1300 umhos/cm, and transmissivity is 1800 gpd/ft. Similar data for the lower zone is 1400 umhos/cm and 15,500 gpd/ft. Dissolved solids is about 1660 mg/liter for water in the leached zone. Water quality for the lower zone indicated by these data is better than the regional hydrology indicates it should be at this location.

(6) Mineral Value: 1/

(a) Mahogany Zone.- Contains about 150 feet of shale averaging 30 gallons of oil per ton in units thicker than 10 feet, with an in-place resource of about 300,000 barrels per acre.

(b) Lower Oil Shale Zones R-1 through R-6: (See Figure II-35, Volume I).- Contains about 750 feet of shale averaging 30 gallons of oil per ton in units thicker than 10 feet with an in-place resource of 1,500,000 barrels per acre. Bedded nahcolite is present in about 500 feet of section and dawsonite is present in more than 700 feet of section. Ground water has leached salts from more than 300 feet of section downward from the lower part of the Mahogany Zone. Highly saline water occupies the voids created by the leaching. Thick beds of halite are interspersed with oil shale and nahcolite in the 300 foot interval immediately underlying the leached zone. The leached zone containing halite probably will present difficult mining problems in as much as 180 feet of 30-gallon shale and a thicker zone of dawsonite-bearing shale.

1/ Average approximately, but not less than 30 gallons/ton. Intervals greater than 10 feet thick and averaging less than 15 gallons/ton were not considered. This same criteria was used for all averaging of oil shale (gallon/ton) in this statement.

Air and Water Quality Characteristics:

(1) Surface Water Quality.- By virtue of the tract location in the middle of the basin, surface water is of moderately poor quality.

(2) Air Quality.- Low mean elevation places the tract in an area of probable nighttime temperature inversions. Drainage winds downslope along Piceance Creek.

Transportation Network:

(1) Roads.- Existing roads are described under "Access."

(2) Pipelines.- The same gas pipeline that traverses Tract C-10 passes through the south portion at this tract.

Power Sources.- Electric power is available in Piceance Creek approximately 2 miles east of the center of the tract. Telephone facility is adjacent to this power source.

Land Use.- Present land use consists of livestock grazing and wildlife habitat.

Vegetation and Soils.- The drainage bottoms are characterized by deep, light-colored soils low in organic matter. These soils generally contain free salts in their profile and support stands of greasewood and other plants which can tolerate these salts. The ridges have a very shallow, light-colored soil over sand, sandstones and shales. There are large inclusions of deep, dark loam soils on the exposures suitable for development of deeper soils.

The shallow soils support stands of pinyon and juniper trees with a sparse understory of perennial grasses and various shrubs. The deeper soils support heavy stands of sagebrush with an understory of perennial grasses.

Plant Species:

(1) Browse

Amelanchier utahensis	Serviceberry
Purshia tridentata	Bitterbrush
Artemisia tridentata	Big sagebrush
Cercocarpus montanus	Mountain mahogany
Atriplex spp.	Saltbush
Chrysothamnus spp.	Rabbitbrush

(2) Grasses

Oryzopsis hymenoides	Indian ricegrass
Agropyron inerme	Beardless bluebunch wheatgrass
Koeleria cristata	Prairie junegrass
Poa spp.	Bluegrass
Elymus cinereus	Basin wildrye
Stipa comata	Needle and thread

(3) Trees

Pinus edulis	Pinyon pine
Juniperus osteosperma	Juniper
Quercus gambellii	Scrub oak

Vegetation Conditions.- These are fair to good on vigor. The tract's adaptability to revegetation is limited by shallow soils on ridges and slopes.

Wildlife.- This tract constitutes an important mule deer winter range area, lying within prime elevational zone. Deer, mountain lion, coyote, bobcat, sage grouse, raptors, doves, rabbits, and numerous small bird and mammal species also inhabit the tract. However, the primary value is as deer winter range and, in addition, it has an active golden eagle nest site. The site is situated abreast of a heavily travelled road utilized yearlong by stockmen and recreationists, seasonally by sportsmen, and frequently by representatives of mining or petroleum companies having an interest in the extensive land areas throughout the Cathedral Bluffs units. This tract lies in the heart of an important wildlife habitat area managed by a state agency primarily for the benefit of wildlife species and hunters. This tract receives horse use during the winter months.

Livestock Grazing.- One operator grazes 1,000 cattle during the spring and fall. 500 AUM's are available per year.

Improvements.- This tract contains a well which is the water source for an extensive pipeline system to provide water for livestock, wildlife, and human consumption associated with hunter camps.

Archeology.- None known or reported on the tract; however, the entire basin was once inhabited by the Ute Indians.

Recreation and Esthetics. - The area is used primarily for hunting and the major values are wildlife.

Environmental Impact of Development

Development by underground mining methods for which this tract appears best suited would probably have the following impacts on the environment:

Water.- The impact would be similar to those described for Tract C-b although water quality in the lower zone, which could require disposal, might be poorer. The Piceance Creek, Ryan Gulch Creek, and springs between the tract and Piceance Creek would be affected. Over time, Black Sulphur Creek and Fawn Creek could be affected also. Stock wells in Ryan Gulch might be affected.

Land.- The impacts on land will be similar to those described for Tract C-b. In addition to those development impacts, 1 mile of new road and a powerline will have to be constructed.

Air.- The impact on air conditions would be similar to those described for Tract C-b, but possibly greater due to the proximity of the nighttime drainage winds and the lower elevation. The tract is in an area of probable nighttime temperature inversions and close to the Piceance Valley air drainage.

Wildlife.- The impact on wild horses and horse range would be approximately the same as for Tract C-6. It would be moderate for horses if no other tracts were developed in this part of the basin. Important deer migration routes would be interfered with and serious disruption of game migration would be likely. Important winter mule deer range would be affected. Bald eagle nesting on the tract could be expected to disappear and eagles would probably abandon the tract. Penetration of an important wildlife habitat and disturbance of state managed wildlife habitat area would occur. The Ryan Gulch county road is used by the state as a major travel corridor for wildlife habitat maintenance and law enforcement. Multiple use conflicts involving use of the road could occur.

Vegetation.- Approximately 25 percent of the tract is pinyon-juniper woodland and 55 percent better soils and site conditions for vegetation such as oak, big sage, mountain mahogany shrub and grasses. However, the nature of the vegetation is such that it is susceptible to heavy erosion. The impacts on this cover are expected to be like those described for Tract C-b and Tract C-6, with similar erosion relationship to soil and water effects. These water effects, of course, are in the prior discussion of water impact.

Grazing.- Interruption of present grazing use would occur affecting approximately 1,000 cattle utilizing 500 AUM's annually and involving one operator.

Recreation.- Considered a prime hunting area, the tract is heavily utilized by sportsmen during the hunting season and generally used throughout the year by other recreationists. This tract lies

within a game management unit which sustains 6,000 hunter days/year which would be reduced. Impact on recreation would be similar to that which would be expected for Tract C-10. The tract is bisected by a scenic road that would probably lose its appeal because of heavy industrial use.

Cultural Features.- The county road leading to other unimproved roads to the southwest providing access to Cathedral Bluffs area would be affected by heavy industrial use and probable reconstruction. Access to the high country would be hindered through the travel corridor. Two reservoirs, two wells, and an extensive pipeline system for stock watering and hunter camp use exists on the tract and would probably be closed out ultimately and alternate water sources provided current users. Access to private lands up Ryan Gulch road could conflict with mining use of the road. Cascade pipeline passes through the southern portion of the tract and could be affected. Powerline construction outside the area would be required. Other off-site impacts are about as for Tract C-b.

Minerals.- Nahcolite and dawsonite resources are present in quantity; 500 foot beds of nahcolite, 700 foot beds of dawsonite shale. Thick beds of halite exist. These minerals would be affected by development and possibly extracted. Oil shale resources averaging 30-gallon per ton that would be affected are estimated to average approximately 1,800 thousand barrels per acre.

Archeological and Historical.- There is no evidence to indicate any effect should be anticipated; however, as the entire

basin was inhabited by the Ute Indians, there are potential impacts on artifacts that could occur.

Socioeconomics.- This impact would be expected to be similar to that described for Tract C-b.

Surface mine development is also feasible at Tract C-11 due to the waste rock to ore ratio of 1.9:1.0. The impacts described above for underground development would be applicable to the impacts caused by surface development with the following major exceptions:

Water.- The impact would be greater than estimated for Tract C-a due to larger pit development. Streams affected would be the same as those described earlier to underground development at this tract.

Land.- Removal of nearly 1,000 feet of overburden and up to 900 feet of oil shale would cause significantly greater land impacts than those described above or elsewhere in this volume for Tract C-a. Tract C-11, being closer to the center of the basin and at a much lower elevation than C-a, would probably not be able to utilize the disposal area outside the basin itself, and disposal near the tract would increase the amount of native vegetation destroyed.

Air.- Similar to those described for Tract C-b, but about 2 times the ambient emission levels due to a larger plant size associated with surface development.

Wildlife, Vegetation, Grazing, Recreation, and Socioeconomics.- Similar in scope as described for underground development at this tract, but the magnitude would be larger.

9. COLORADO TRACT ALTERNATIVE C-12

Description

Tract Alternative C-12.- This tract lies just south of the White River in the north end of the Piceance Creek Basin (See Figure IX-11). The tract totals 5,120 acres. The legal description is as follows:

T. 2 N., R. 98 W., 6th P.M. Rio Blanco Co., Colo.

Sections:	7 -	All
	8 -	$S\frac{1}{2}$, $S\frac{1}{2}N\frac{1}{2}$, $NW\frac{1}{4}NW\frac{1}{4}$
	9 -	$SW\frac{1}{4}$, $S\frac{1}{2}SE\frac{1}{4}$
	10 -	$SW\frac{1}{4}SW\frac{1}{4}$
	15 -	$W\frac{1}{2}W\frac{1}{2}$
	16 -	All
	17 -	All
	18 -	All
	19 -	$N\frac{1}{2}$
	20 -	$N\frac{1}{2}$
	21 -	$N\frac{1}{2}$, $N\frac{1}{2}S\frac{1}{2}$
	22 -	$W\frac{1}{2}NW\frac{1}{4}$, $NW\frac{1}{4}SW\frac{1}{4}$

T. 2 N., R. 99 W., 6th P.M. Rio Blanco Co., Colo.

Sections:	12 -	$E\frac{1}{2}E\frac{1}{2}$
	13 -	$E\frac{1}{2}E\frac{1}{2}$
	24 -	$NE\frac{1}{4}NW\frac{1}{4}$

The entire tract is public domain. It is covered by post-1920 claims. In R. 2 N., R. 99 W., Section 8 - $E\frac{1}{2}$ has 1 layer pre-1920 placer mining claims. Section 9 - $S\frac{1}{2}$ has 2 layers of pre-1920 placer mining claims. Section 10 - $SW\frac{1}{4}$ has 1 layer pre-1920 placer mining claims. Section 15 - $W\frac{1}{2}$ has 1 layer pre-1920 placer mining claims. The entire Section 16 has 1 or more layers of pre-1920 placer mining claims. Section 17 - $E\frac{1}{2}$ and $SW\frac{1}{4}$ have 1 or more layers pre-1920 placer mining claims. Section 20 - $N\frac{1}{2}$ has 2 layers of pre-1920 placer mining claims. All of Section 21 has 1 or more pre-1920 placer mining claims.

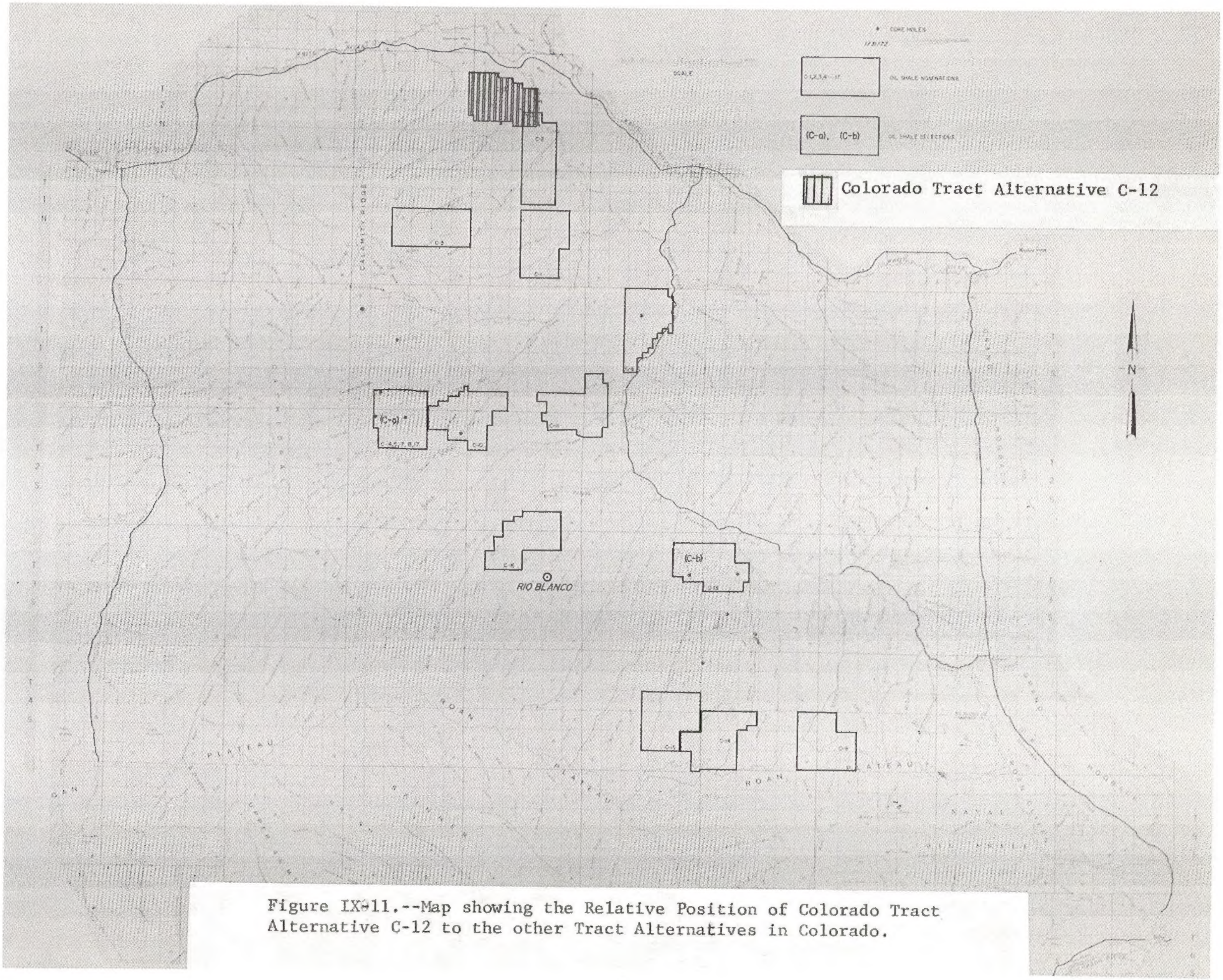

Figure IX-11.--Map showing the Relative Position of Colorado Tract Alternative C-12 to the other Tract Alternatives in Colorado.

Elevation. - The elevation ranges from 5700'- 6800' above mean sea level.

Climate.- Average annual rainfall is 15 to 17 inches. The annual temperature ranges from -40° F to +95° F seasonally. The approximate mean annual temperature 45 F.

Access.- Access to the center of this site is from State Highway #64 at the confluence of Yellow Creek and the White River. Access will have to be obtained through private land. The present road lies along the west side of the Yellow Creek drainage to the confluence of Greasewood Creek and Yellow Creek, then up the Greasewood Creek drainage, a total of approximately 4 miles. The present road location can be upgraded with little realignment.

Vegetative Type.- Pinyon-juniper and sagebrush are the major vegetative types in this area. The sagebrush occurs in the drainage bottoms along with rabbit brush. At the lower elevations, the bottoms have greasewood interspersed with the sagebrush. The pinyon-juniper occurs on the slopes and ridges.

Geologic Features:

(1) Alluvium.- Percent of area is 15 percent. Its composition consists of clay, silt, sand and marlstone fragments with a thickness of 0-200 feet.

(2) Evacuation Creek Member of the Green River Formation.- Percent of area is 60 percent. Its composition consists mostly of calcareous sandstone and siltstone with minor amounts of marlstone with a thickness of 0-600 feet.

(3) Parachute Creek Member of the Green River Formation.- Percent of area is 90 percent. Its composition consists of oil shale (mostly low grade), sandstone, siltstone, and marlstone with a thickness of 0-700 feet.

(4) Hydrology.- A test hole was drilled in Sec. 20, T. 2 N., R. 98 W., to a depth of 1,025 feet. The well is not known to have reached the lower zone. The electrical conductance of the water was 12,000 umhos/cm below a depth of 900 feet. No aquifer tests were made. It is estimated that the transmissivity may be fairly low; less than 5,000 gpd/ft.

(5) Mineral Value.[1/] The following data is based on information gathered from areas outside the nominated tract:

(a) Mahogony Zone.- Probably contains no oil shale averaging 30 gallons of oil per ton in thicknesses greater than 10 feet.

(b) Lower Oil Shale Zone RI-R6.- (See Figure II-35, Chapter II, Volume I). From the outcrop, it is apparent that this zone is thin and low grade, and it is possible that it contains no oil shale averaging 30 gallons per ton in zones thicker than 10 feet. Probably several hundred feet contains disseminated dawsonite of varying amounts and there is probably very little nahcolite.

(6) Structure.- There are no apparent faults. The rocks strike to the west or northwest. Dip is south or southwest at rates ranging from 200 feet per mile in the southwest to more than 400 feet per mile in the northeast.

Air and Water Quality Characteristics:

(1) Surface Water Quality.- Quality at the tract is esti-

1/ Average approximately, but not less than 30 gallons/ton. Intervals greater than 10 feet thick and averaging less than 15 gallons/ton were not considered. This same criteria was used for all averaging of oil shale (gallon/ton) in this statement.

mated to range from good in stream headwaters to very poor in lower reaches of perennial streams.

(2) Air Quality.- Low elevation increases the tract's potential for thermal inversions. Nightime drainage winds are prevalent on the tract and, combined with its low elevation, the potential for concentration of emissions is high on the tract and in the surrounding area.

Transportation Network:

(1) Roads.- Existing roads are described under "Access."

(2) Pipelines.- Natural gas pipeline 1 mile north.

Power Sources.- Power for this tract is available from a power line along the White River approximately 1.5 miles north of the center of the tract. There should be no difficulty and little surface disturbance involved in constructing a power line to the tract. Telephone facilities are available approximately 1.5 miles north.

Land Use.- Present land use consists of livestock grazing and wildlife habitat.

Vegetation and Soils.- The drainage bottoms are characterized by deep, light colored soils low in organic matter. These soils generally contain free salts in their profile and support stands of greasewood and other plants which can tolerate these salts. The ridges have a very shallow, light colored soil over sandstones and shales. There are large inclusions of deep, dark loam soils on the exposures suitable for development of deeper soils.

The shallow soils support stands of pinyon and juniper trees with a sparse understory of perennial grasses and various shrubs.

The depper soils support heavy stands of sagebrush with an understory of perennial grasses.

Plant Species:

(1) Browse

Amelanchier utahensis	Serviceberry
Purshia tridentata	Bitterbrush
Artemisia tridentata	Big sagebrush
Cercocarpus montanus	Mountain mahogany
Atriplex spp.	Saltbush
Chrysothamnus spp.	Rabbitbrush

(2) Grasses

Oryzopsis hymenoides	Indian ricegrass
Agropyron inerme	Beardless bluebunch wheatgrass
Koeleria cristata	Prairie junegrass
Poa spp.	Bluegrass
Elymus cinereus	Basin wildrye
Stipa comata	Needle and thread

(3) Trees

Pinus edulis	Pinyon pine
Juniperus osteosperma	Juniper
Quercus gambellii	Scrub oak

Vegetation Conditions.- Fair to good on vigor. Revegetation adaptability is limited by shallow soils on ridges and slopes.

Wildlife.- Mule deer are numerous particularly in the winter. Mountain lion, coyote, bobcat, chuckar, doves, rabbits, raptors, numerous small bird and mammal species, golden eagle nesting sites and bald eagle winter-roost habitat also exist on the tract.

The wildlife habitat is important deer winter range for mule deer.

The tract and surrounding area also has been utilized by wild horses for winter range.

There is little current use of lands within the vicinity of tract #C-12, other than by recreationists or agricultural interests.

Livestock Grazing.- 365 head of cattle graze on the tract during the spring and fall. 500 AUM's are available.

Improvements.- No significant improvements.

Archeology.- None known or reported on site, however, the entire Basin once was inhabited by the Ute Indians.

Recreation and Esthetics. - Area is used primarily for hunting. Major recreation values are for wildlife use.

Environmental Impact of Development

Development by either the underground mining or the in situ mining method both of which appear to have fair to good potential, would probably have the following environmental impacts:

Water.- With underground mining, this tract would be expected to have approximately the same impacts on water supply and water quality as those described for Tracts #1, 2, 6, or C-b (i.e., C-13). Yellow Creek and the White River would be most directly affected. Little Spring Creek, Greasewood Creek, Barcus Creek and a well up the canyon and a well up the south fork of Greasewood Gulch could be affected. It is likely that the spring at the confluence of Greasewood Gulch and Yellow Creek would dry up over time.

With in situ mining or a combination of in situ and underground, the impacts would be approximately the same as those described for Tract W-a.

Air.- The impact on air quality should be similar to that described for Tract C-1.

Vegetation.- The expected impact on vegetation would be similar to that for Tract C-2. There are more pinyon-juniper wood-

land sites (35% compared with 20%), than on C-2, that would be affected.

Wildlife.-The tract's location adjacent to a major surfaced highway means that the industrial penetration of the wildlife habitat would be at the edge of the Basin. Relative to Tracts C-a, 10 and 11, penetration would not be of major significance on critical winter range, although important deer areas would be affected. Other wildlife effects would be similar to those expected for Tract C-2; localized loss of wildlife habitat, disruption of game movements, and penetration of habitat management areas, Golden eagle nesting sites on the tract would be disturbed and eagles displaced. Adjoining bald eagle winter-roost habitat just north of the site, causing displacement of the eagles. Impact on wild horses and their range would be moderate, and less than on Tracts C-1, 2 and 3.

Grazing.- Five (5) operators utilize the general area grazing about 350-980 cattle during fall, winter and spring months. About 500 AUM's of forage are harvested. These operations would be at least partially interrupted and grazing moved elsewhere.

Recreation.- Year-round use by sportsmen and general recreationists would be impeded. The impact would be similar to those described for Tract C-6.

Cultural Features.- It is likely that a road through the tract which lies along the west side of Yellow Creek would be improved. Conflict could occur between industrial use of the tract road and public use for access to the high country south and west.

Powerline construction effects would be likely for about 1.5 miles north to the water power source line along the White River. Development would also affect private land along the road because of the need to purchase access rights.

Minerals.- Nahcolite and dawsonite are presumed to be present. The quantity and quality of oil shale resources are unknown, but presumed to be submarginal for a commercial oil shale operation.

Archeological & Historical.- There is no evidence to indicate any effect should be anticipated, however, as the entire basin once was inhabited by Ute Indians, possible impacts on artifacts could occur.

Socioeconomic.- This impact would be expected to be roughly similar to that for Tract C-b.

10. COLORADO TRACT ALTERNATIVE C-13

Description

Tract Alternative C-13.- This tract lies south of Piceance Creek between Willow Creek and the Middle Fork of Stewart Gulch (See Figure IX-12). It is listed as Site C-b in the Environmental Impact Statement. Its legal description is as follows:

T. 3 S., R. 96 W., 6th P.M., Rio Blanco Co., Colo.

Section:
- 5 - W½, SE¼, SW¼
- 6 - Lots 6, 7; E½SW¼, SE¼
- 7 - Lots 1, 2, 3, 4; E½, W½, E½
- 8 - W½NE¼, NW¼S½
- 9 - SW¼
- 16 - NW¼, W½SW¼
- 17 - All
- 18 - Lots 1, 2, 3, 4; E½, W½, E½

T. 3 S., R. 97 W., 6th P.M., Rio Blanco Co., Colo.

Section:
- 1 - S½
- 2 - SE¼
- 11 - E½
- 12 - All
- 13 - N½
- 14 - N½, NE¼

Total - 5,093.90 acres

The tract is entirely on public domain land. The following mining claim conflicts exist: T. 3 S., R. 96 W., sec. 7: S½S½, covered by 1 layer pre-1920 placer mining claims. Entire tract except for sec. 11: E½, sec. 12: SW¼, sec. 14: N½NE¼; T. 3 S., R. 97 W., sec. 5: SW¼, sec. 8: W½NE¼, sec. 16: W½SW¼, covered by 1 layer post-1920 placer mining claims.

Elevation.- Tract elevation ranges from 6,600 feet to 7,000 feet above mean sea level.

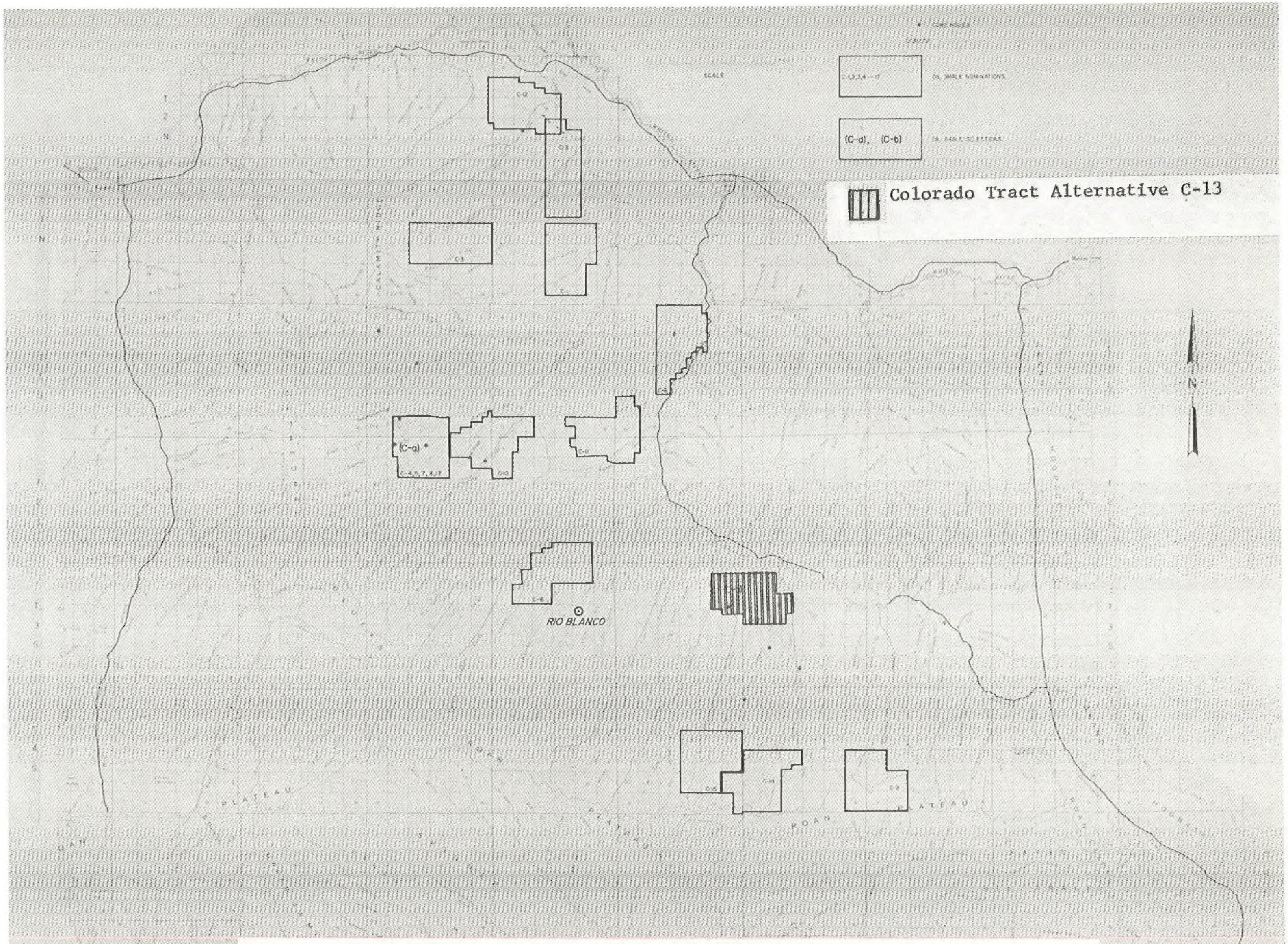

Figure IX-12.--Map showing the Relative Position of Colorado Tract Alternative C-13 to the other Tract Alternatives in Colorado.

Climate.- Average annual rainfall is 15 to 17 inches. The annual temperature ranges from $-40^{o}F$ to $+95^{o}F$ seasonally. The approximate mean annual temperature is $45^{o}F$.

Access.- Present access is from Piceance Creek through Stewart Gulch near the Oldland Ranch headquarters. A jeep trail cuts across the eastern section of the tract in a north-south direction. On the west side of the tract, another jeep trail exists.

Vegetative Type.- Pinyon-juniper and sagebrush are the vegetative types in this area. The sagebrush occurs in the drainage bottoms along with rabbit brush. At the lower elevations the bottoms have greasewood interspersed with the sagebrush. The pinyon-juniper occurs on the slopes and ridges.

Geologic Features:

(1) Alluvium.- Percent of area is from 5 to 10 percent. Its composition consists of clay, silt, sand, marlstone fragments with a thickness of 0-100 feet.

(2) Evacuation Creek Member of the Green River Formation.- Percent of area, 100 percent. Its composition consists mostly of calcareous sandstone and siltstone with minor amounts of marlstone and low grade oil shale. Thickness ranges from 300 to 600 feet. Some zones contain a high percent of analcime; extractable alumina may be present.

(3) Parachute Creek Member of the Green River Formation.- Percent of area, 100 percent. Its composition consists of oil shale with some sandstone and thin beds of analcime. Probably contains nahcolite (bedded in the northwest corner of tract) and dawsonite. Thickness is about 1500 feet.

(4) Structure.- No faults are apparent. The rocks strike to the east or northeast in most of the tract. The axis of a syncline is subparallel to the northern boundary of the tract and the strike of the rocks is to the northwest. The dip in most of the area is north to north-northwest at the rate of 150 feet per mile. Along the northern boundary the dip is southwest at the rate of 200 feet per mile.

(5) Hydrology.- Hydrologic tests near the tract indicate a conductance for water in the upper zone of from 800 - 2000 before umhos/cm and a transmissivity for the upper zone of 5000 gpd/ft. The lower zone had a conductance as high as 20,000 umhos/cm and a transmissivity of 1500 to 6000 gpd/ft. Data for this tract seem to indicate a lesser problem of mine drainage and water disposal, than for those tracts located nearer the structural center of the basin.

(6) Mineral Value.- [1/]

(a) Mahogany Zone.- This zone contains about 140 feet of oil shale averaging 30 gallons of oil per ton in units thicker than 10 feet with an in-place resource of about 280,000 bbls per acre.

(b) Lower Oil Shale Zones R-1 through R-6 (See Figure II-35, Chapter II, Volume I).- Contains about 210 feet of oil shale averaging 30 gallons of oil per ton in units thicker than 10 feet with an in-place resource of about 420,000 bbls per acre. The tract also contains bedded nahcolite in the northwest part and pods of nahcolite scattered through several hundred feet of section. About 300 feet of oil shale contains dawsonite in

1/ Average approximately, but not less than 30 gallons/ton. Intervals greater than 10 feet thick and averaging less than 15 gallons/ton were not considered. This same criteria was used for all averaging of oil shale (gallon/ton) in this statement.

varying quantities. The upper part of the zone formerly contained saline minerals that have been leached by ground water. The voids created by leaching now contain water of fair quality. However the quantity of water would present mining problems in this part of the section.

Air and Water Quality Characteristics:

(1) Surface Water Quality.- Surface waters in the area are of moderately good quality.

(2) Air Quality.- Tract elevation suggests that fewer problems would be associated with stagnation. However, the location of the tract near the middle of the topographic basin suggests possible movement of gases with drainage winds.

Transportation Network:

(1) Roads.- Existing roads are described under "Access".

(2) Pipelines.- No pipelines on tract, however, gas pipeline is located along Piceance Creek.

Power Sources.- Power is available at Piceance Creek 2.5 miles north of the center of the tract. Telephone facilities are adjacent to this powerline.

Land Use.- Present land use consists of livestock, grazing and wildlife habitat uses.

Vegetation and Soils.- The drainage bottoms are characterized by deep, light colored soils low in organic matter. These soils generally contain free salts in their profile and support stands of greasewood and other plants which can tolerate these salts.

The ridges have a very shallow, light colored soil over sandstones and shales. There are large inclusions of deep, dark loam soils on the exposures suitable for development of deeper soils.

The shallow soils support stands of pinyon and juniper trees with a sparse understory of perennial grasses and various shrubs. The deeper soils support heavy stands of sagebrush with an understory of perennial grasses.

Plant Species:

(1) Browse

Amelanchier utahensis	Serviceberry
Purshia tridentata	Bitterbrush
Artemisia tridentata	Big sagebrush
Cercocarpus montanus	Mountain mahogany
Atriplex spp.	Saltbush
Chrysothamnus spp.	Rabbitbrush

(2) Grasses

Oryzopsis hymenoides	Indian ricegrass
Agropyron inerme	Beardless bluebunch wheatgrass
Koeleria cristata	Prairie junegrass
Poa spp.	Bluegrass
Elymus cinereus	Basin wildrye
Stipa comata	Needle and thread

(3) Trees

Pinus edulis	Pinyon pine
Juniperus osteosperma	Juniper
Quercus gambellii	Scrub oak

Vegetation Conditions.- Adaptability to revegetation is fair to good on vigor. Limited by shallow soils on ridges and slopes.

Wildlife.- Deer, elk, bear, coyote, mountain lion, bobcat, blue grouse, sage grouse, rabbits, raptors, golden eagle, and numerous small bird and mammal species exist on the tract. Game harvest and general recreational use is somewhat limited by the current actions of landowners.

The tract and the surrounding area has been utilized by horses for winter range. The tract has limited value as deer and elk winter range, and provides some eagle nesting habitat.

Livestock Grazing.- This tract covers a portion of one grazing allotment. There are five livestock operators who graze 3781 cattle on this allotment during spring and fall months. Approximately 650 AUM's on this tract.

Improvements.- None of any significance.

Archeology.- None known or reported on site, however, the Ute Indians did inhabit the entire basin at one time.

Recreation and Esthetics. - The area is used primarily for hunting and major values are wildlife.

Environmental Impact of Development

Tract C-13 is also designated Tract C-b in this proposal. Its environmental impact has been described in Sections A through G Chapter IV of this volume. The oil shale resources that would be affected by its development are estimated at approximately 700 thousand bbls/acre.

11. COLORADO TRACT ALTERNATIVE C-14

Description

Tract Alternative C-14.- This tract lies west of Tract C-9 in the southern part of the Piceance Creek Basin (See Figure IX-13). Its legal description covers a total of 5,120, consisting of the following lands:

<u>T. 4 S., R. 96 W., 6th P.M.; Garfield Co., Colo.</u>

Section: 19 - Lots 1, 2, 3, 4, E½NW¼, E½, E½SW¼
20 - All
21 - N½, SW¼, N½SE¼
29 - All
30 - Lot 6, E½W½, E½
31 - Lots 1, 2, 3, 4, E½W½, E½
32 - All

<u>T. 4 S., R. 97 W., 6th P.M.; Garfield Co., Colo.</u>

Section: 25 - All
36 - E½

The tract is all public domain except for certain lands which are patented with at least oil shale reserved to the United States. The patented lands are described as: T. 4 S., R. 96 W., sec. 29, all except NW¼NW¼; sec. 30, SE¼, E½SW¼; sec. 31, N½NE¼, NE¼NW¼; sec. 32, E½, NW¼; T. 4 S., R. 97 W., sec. 25, NW¼, NW¼NE¼.

The entire tract is covered by one or more layers of pre-1920 placer mining claims. Post-1920 placer mining claims cover sec. 19, sec. 20, and N½ sec. 21, T. 4 S., R. 96 W.; S½ sec. 25 and E½ sec. 36, T. 4 S., R. 97 W.

<u>Elevation</u>.- Ranges from 7,500-8,200 feet above mean sea level.

<u>Climate</u>.- Average annual rainfall is 20 to 25 inches. The annual temperature ranges from -40°F to +95°F. The approximate mean annual temperature is 45°F.

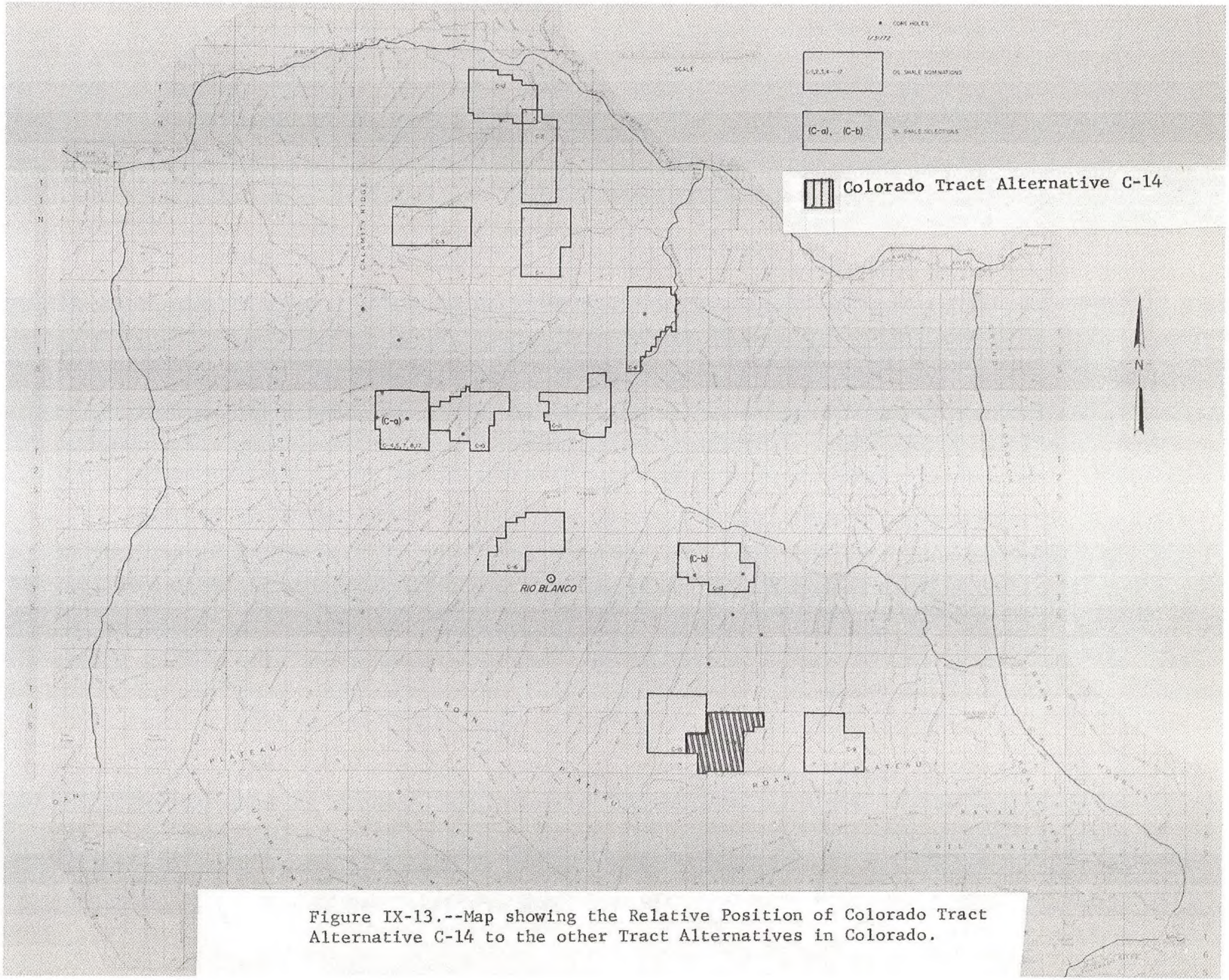

Figure IX-13.--Map showing the Relative Position of Colorado Tract Alternative C-14 to the other Tract Alternatives in Colorado.

Access.- Access is from Piceance Creek near the Oldland Ranch headquarters. Other access could be developed into this area on BLM Road No. 1112 by joining the Piceance Creek Road at the North Quarter Corner sec. 36, T. 3 S., R. 97 W. The road would cross Piceance Creek at this point then proceed south on the ridge between Scandard Gulch and Sorghum Gulch. This route would serve Tract C-14 with a road 10 miles in length.

Vegetative Type.- Mountain browse is the major vegetative type in this area.

Geologic Features:

(1) Alluvium.- Percent of area is 5 percent. Its composition consists of clay, silt, sand and marlstone fragments with a thickness of 0 to 50 feet.

(2) Evacuation Creek Member of the Green River Formation.- Percent of area, 90 percent. Its composition consists mostly of sandstone and siltstone with minor amounts of marlstone and low grade oil shale. Thickness ranges from 0 to 800 feet. Some units contain appreciable quantities of analcime; there may be some extractable alumina.

(3) Parachute Creek Member of the Green River Formation.- Percent of area, 100 percent. Its composition consists mostly of oil shale with some thin beds of sandstone and analcime and minor amounts of nahcolite. Thickness ranges from 1,000 to 1,200 feet.

(4) Structure.- There are no apparent faults. The strike in most of the area is generally to the west. The dip is about 200 feet to the mile to the north.

(5) Hydrology.- No hydrologic data are available for this tract. However, considering the relatively great distance of the tract from the center of the basin where ground water is highly mineralized and the topographic position of the tract, it is likely that quality of ground water is good and that the quantity of ground water in the upper zone is small (no consideration was given to the lower zone).

(6) Mineral Value.- 1/

(a) Mahogany Zone.- The Mahogany Zone contains 100 to 130 feet of oil shale that averages 30 gallons of oil per ton in zones thicker than 10 feet, with an in-place resource of 200-260 thousand barrels of shale **oil** per acre.

(b) Lower Oil Shale Zones (R-1 through R-6) (See Figure II-35, Chapter II, Volume I).- The lower three R zones probably are not present and the remaining three are poorly developed. There probably is no shale averaging 30 gallons of oil per ton in units thicker than 10 feet. The amount of nahcolite is insignificant and probably less than 100 feet of shale contains dawsonite in significant quantities.

Air and Water Quality Characteristics:

(1) Surface Water Quality.- Surface waters are essentially good quality runoff waters.

1/ Average approximately, but not less than 30 gallons/ton. Intervals greater than 10 feet thick and averaging less than 15 gallons/ton were not considered. This same criteria was used for all averaging of oil shale (gallon/ton) in this statement.

(2) Air Quality.- The tract's high elevation reduces the possibility of stagnation or inversion. The tract is closest to Rifle, but prevailing winds would probably direct emissions to the northeast.

Transportation Network:

(1) Roads.- Existing roads are described under "Access."

(2) Pipelines.- None in the vicinity.

Power Sources.- Electric power is available from the power line in Piceance Creek Basin and a power line to the tract could easily follow the same alignment as an existing road. Telephone facilities are adjacent to this power line.

Land Use.- Present land use consists of livestock, grazing, and wildlife habitat uses.

Vegetation and Soils.- Soils are generally deeper, 20 - 30 feet, than in the tracts located northwest of this area. Soils are also darker and more fertile.

Plant Species:

(1) Browse

Amelanchier utahensis	Serviceberry
Symphoricarpos tetonensis	Snow berry
Purshia tridentata	Bitterbrush
Cercocarpus montanus	Mountain mahogany
Artemisia tridentata	Big sagebrush

(2) Grasses

Agropyron inerme	Beardless bluebunch wheatgrass
Poa spp.	Bluegrass
Stipa spp.	Stipa
Oryzopsis hymenoides	Indian ricegrass
Elymus cinereus	Basin wildrye
Bromus carinatus	Mountain brome

(3) Trees

Pinus edulis	Pinyon pine
Juniperus osteosperma	Juniper
Populus tremuloides	Aspen
Pseudotsuga menziesii	Douglas-fir
Quercus gambellii	Scrub oak

Vegetation Conditions.- Conditions are fair to good on vigor. The tract's adaptability to revegetation is limited by shallow soils on ridges and slopes.

Wildlife.- The tract is a spring, summer and fall deer range and receives some utilization as an elk winter range.

Also existing on the tract are deer, elk, bear, coyote, mountain lion, bobcat, blue grouse, sage grouse, rabbits, raptors, as well as numerous small bird and mammal species.

The tract is situated in a relatively remote wildlife range area and is subject to little agricultural or recreational activity. Considerable ranch maintenance and livestock traffic prevails. However, restrictive access somewhat limits game harvest or general recreational use by the public. This tract lies near the south-eastern edge of the basin at elevations well above the more critical deer winter-use zone. The tract is not subject to priority management for wildlife.

Livestock Grazing.- Cattle and sheep graze this tract during the summer months. During the spring and fall months the livestock are off the tract to the north.

4,077 cattle and 4,124 sheep are licensed to graze within the areas covered by Tracts C-9, C-14, and C-15. Approximately 600 AUM's are available on this tract.

Improvements.- None of any significance.

Archeology.- None known or reported on tract; however, the Ute Indians at one time inhabited the entire basin.

Recreation and Esthetics.- The area is used for hunting and its major values are wildlife.

Environmental Impact of Development

Development by underground mining methods would probably have the following environmental impacts:

Water.- The impact on water supply and water quality in the Piceance Basin should be similar to that described for Tract C-9. Ground water withdrawal effects, should they occur, would probably impact about 9 wells and 30 springs within radius of the tract. The tract is located high on the recharge area of the basin. Any water quality effects would impact upon the headwaters of Parachute Creek to the south and Piceance Creek to the north.

Air.- The expected effect on air quality should be similar to that described for Tract C-9.

Land.- The impact on topography and land disturbance should be approximately the same as that described for Tract C-a. Tributary canyons of East Fork, Middle Fork and West Fork of Stewart Gulch and Willow Creek could be utilized as disposal areas and such utilization would level some of the rugged topography.

Vegetation.- Good grass and shrub sites occupy approximately 95% of the area. Only 5% of the tract is pinyon-juniper woodland. Effects on vegetative cover would be approximately the same as those described for Tract C-9 and Tract C-b.

Wildlife.- The impact on wildlife would be expected to be similar to that described for Tract C-9. Deer, bear, elk, bobcat, mountain lion, blue grouse, sage grouse, rabbits, raptors and numerous small animals and birds would be affected. Elk range over this tract during summer and winter and would be driven away.

Grazing.- The impacts would be similar to those described for Tract C-9. The same operators and herds range the area, except for the sheep. The sheep operation would probably not be affected as the sheep do not range on the tract. The cattle operations involving 5 operators would be affected as in a manner similar to that described for Tract C-9.

Recreation.- The impact would be similar to that described for Tract C-9.

Cultural Features.- Access to the area is controlled by private owners and development would affect their land and property rights. A primitive road from Parachute Creek, over the divide and down into the Middle Fork of Stewart Gulch probably would be improved, opening access into the high country to greater traffic and larger vehicles. General off-tract impacts would be approximately the same as those described for Site C-b.

Minerals.- The oil shale resources that would be affected by development approximate 230 thousand bbls/acre.

Archeological and Historical.- There is no evidence to indicate any effects should be anticipated; however, since the entire basin was inhabited by the Ute Indians, possible impact on artifacts may occur.

Socioeconomic.- The impact would be roughly similar to that described for Tract C-b.

12. COLORADO TRACT ALTERNATIVE C-15

Description

Tract Alternative C-15.- This tract lies in the southern part of the Piceance Creek Basin adjacent to the western boundary of Tract C-14 (See Figure IX-14). Its legal description is as follows:

T. 4 S., R. 97 W., 6th P.M.; Garfield Co., Colo.

Sections: 13 - All
14 - All
15 - All
22 - All
23 - All
24 - All
26 - All
27 - All

The total area comprises 5,120 acres. All of the tract is public domain except for the following parcel which is patented with at least oil shale reserved to the United States: sec. 13, W½NW¼; sec. 14, E½E½, W½SE¼, SW¼NE¼, SE¼SW¼; sec. 23, W½NE¼, SE¼NW¼, NE¼SW¼; sec. 24, S½, S½NE¼, sec. 25, NW¼, NW¼NE¼; sec. 26, SE¼NE¼. The following mining claim conflicts exist: sec. 13, E½E½E½; sec. 22, all; sec 23, all; sec. 24, all; sec 26, all; sec 27, all covered by one layer pre-1920 placer mining claims. Sec. 13, E½, E½W½; sec. 14, W½W½, NE¼SW¼, E½NW¼, NW¼NE¼; sec. 15, all; sec. 22, all; sec. 26, S½, NW¼; sec. 27, all covered by one layer of post-1920 placer mining claims.

Elevation.- Ranges from 7,500 feet to 8,300 feet.

Climate.- Average annual rainfall is 20 to 25 inches. The annual temperature ranges from -40°F to +95°F. The approximate mean annual temperature is 45°F.

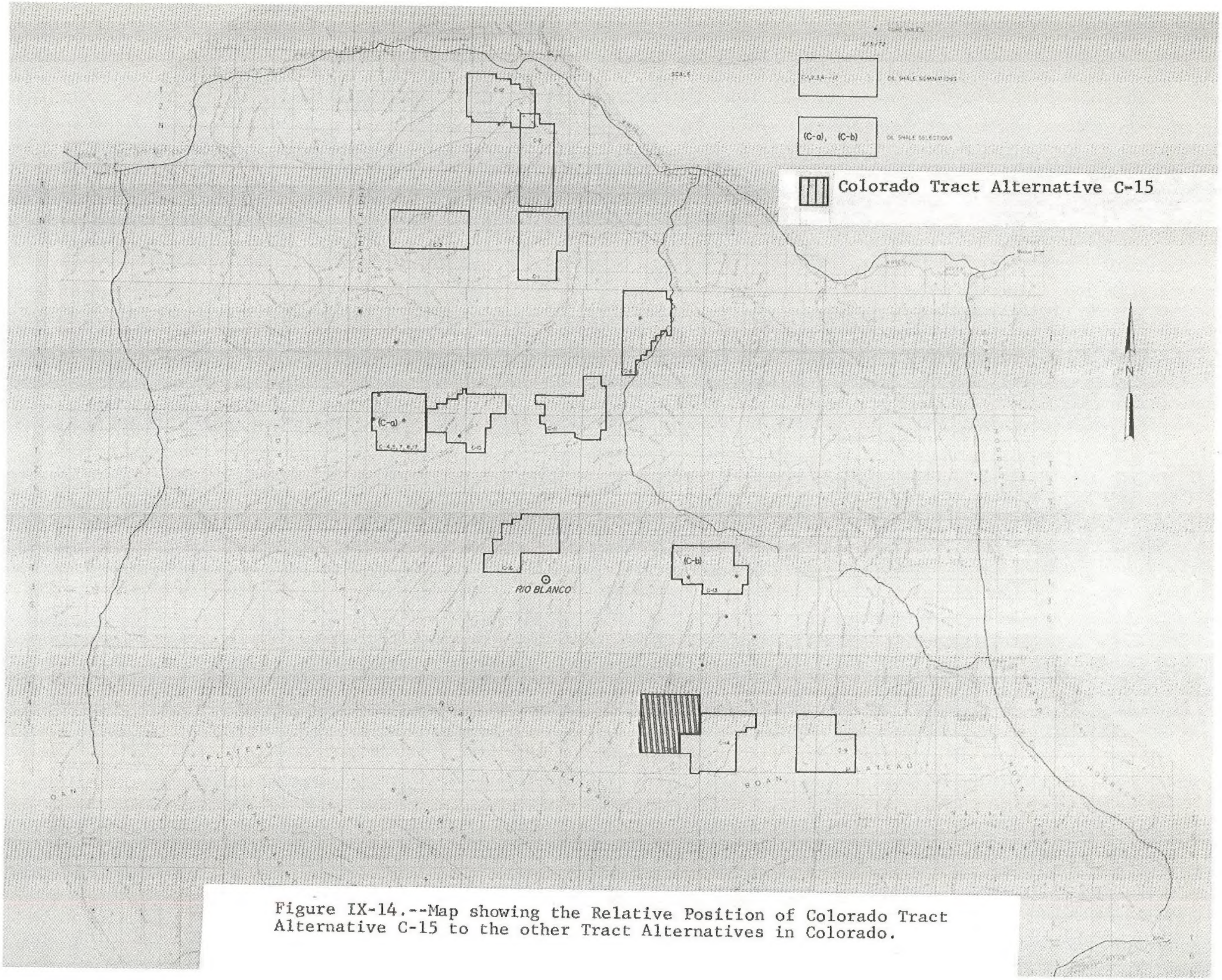

Figure IX-14.--Map showing the Relative Position of Colorado Tract Alternative C-15 to the other Tract Alternatives in Colorado.

Access.- Access to Tract C-15 is most readily available from Piceance Creek approximately 8.5 miles north of the center of the tract along the Sprague Gulch Road - BLM No. 1112. The road is unimproved but the alignment is fair and can be easily upgraded.

Vegetative Type.- Mountain browse.

Geologic Features:

(1) Alluvium.- Percent of area - 5 percent. Its composition consists of clay, silt, sand and marlstone fragments with a thickness from 0 to 50 feet.

(2) Evacuation Creek Member of the Green River Formation.- Percent of area, 90 percent. Its composition consists mostly of sandstone and siltstone with minor amounts of marlstone and low grade oil shale. Thickness ranges from 0 to 800 feet. Some units contain appreciable quantities of analcime; there may be some extractable alumina.

(3) Parachute Creek Member of the Green River Formation.- Percent of area, 100 percent. Its composition consists mostly of oil shale with some thin beds of sandstone and analcime and minor amounts of nahcolite. Thickness ranges from 1,000 to 1,200 feet.

(4) Structure.- Faults are not apparent. The strike is generally to the west. The dip is about 200 feet to the mile to the north.

(5) Hydrology.- No hydrologic data are available for this tract. However, considering the relatively great distance of the tract from the center of the basin where ground water is highly mineralized

and given its topographic position, it is likely that the quality of ground water is good and that the quantity of ground water in the upper zone is small (no consideration was given to the lower zone).

(6) Mineral Value.-

(a) Mahogany Zone.- The Mahogany Zone contains 100 to 130 feet of oil shale that averages 30 gallons of oil per ton in zones thicker than 10 feet, with an in-place resource of 200 to 260 thousand bbls. of shale oil per acre.

(b) Lower Oil Shale Zones (R-1 through R-6) (See Figure II-35, Chapter II, Volume I).- The lower three R zones probably are not present and the remaining three are poorly developed. There probably is not any shale averaging 30 gallons of oil per ton in units thicker than 10 feet. The amount of nahcolite is insignificant and probably less than 100 feet of shale contains dawsonite in significant quantities.

Air and Water Quality Characteristics:

(1) Surface Water Quality.- Surface waters are essentially good quality runoff waters.

(2) Air Quality.- The high elevation of the tract lessens the possibility of stagnation or inversion if gaseous emissions occur on tract. The tract is closest to Rifle, but prevailing winds should direct emissions to the northeast.

Transportation Network:

(1) Roads.- Existing roads are described under "Access."

(2) Pipelines.- None in the vicinity.

1/ Average approximately, but not less than 30 gallons/ton. Intervals greater than 10 feet thick and averaging less than 15 gallons/ton were not considered. This same criteria was used for all averaging of oil shale (gallon/ton) in this statement.

Power Sources.- Electric power is available from the power line in Piceance Creek Basin, and the power line to the tract could easily follow the same alignment as the road. Telephone facilities are adjacent to this power line.

Land Use.- Present land use consists of livestock, grazing and wildlife habitat uses.

Vegetation and Soils.- Soils are generally depper, 20 to 36 inches, than in the tracts located northwest of this area. Soils are also darker and more fertile.

Plant Species:

(1) Browse

Amelanchier utahensis	Serviceberry
Symphoricarpos tetonensis	Snow berry
Purshia tridentata	Bitterbrush
Cercocarpus montanus	Mountain mahogany
Artemisia tridentata	Big sagebrush

(2) Grasses

Agropyron inerme	Beardless bluebunch wheatgrass
Poa spp.	Bluegrass
Stipa spp.	Stipa
Oryzopsis hymenoides	Indian ricegrass
Elymus cinereus	Basin wildrye
Bromus carinatus	Mountain brome

(3) Trees

Pinus edulis	Pinyon pine
Juniperus osteosperma	Juniper
Populus tremuloides	Aspen
Pseudotsuga menziesii	Douglas-fir
Quercus gambellii	Scrub oak

Vegetation Conditions.- Conditions are fair to good on vigor. The tract's adaptability to revegetation is limited by shallow soils on ridges and slopes.

Wildlife.- During the spring, summer and fall deer range on the tract. It also receives some utilization as an elk winter range.

Deer, elk, bear, coyote, mountain lion, bobcat, blue grouse, sage grouse, rabbits, raptors, as well as numerous small bird and

mammal species exist on the tract.

The tract is situated in a relatively remote wildlife range area and is subject to agricultural or recreational activity. Considerable ranch maintenance and livestock traffic prevails. However, restrictive access somewhat limits game harvest or general recreational use by the public. This tract lies near the southeastern edge of the basin at elevations well above the more critical deer winter-use zone. The tract is not subject to priority management for wildlife, and currently receive limited recreational use because of restrictive public access provisions.

Livestock Grazing.- Cattle and sheep graze this tract during the summer months. During the spring and fall months, the livestock are off-tract to the north.

4,077 cattle and 4,124 sheep are licensed to graze within the areas covered by Tracts C-9, C-14, and C-15. Approximately 600 AUM's are available on this tract.

Improvements.- None of any significance

Archeology.- None known or reported on tract, however, the Ute Indians once inhabited the entire basin.

Recreation and Esthetics. - The area is used primarily for hunting and major values are wildlife.

Environmental Impact of Development

Development by underground mining methods would probably have the following environmental effects:

Water.- The impact would be similar to that described for Tract C-9. Ground water withdrawal effects, should they occur, might affect 5 wells and about 20 springs in the recharge area of

the basin. Hunter Creek, Willow Creek, Stewart Creek and Parachute Creek headwater streams quite possibly would be in the impact zone. Any quality effects, should they occur, would influence conditions in Piceance Creek and Parachute Creek waters.

Land.- The impact would be similar to those described for Tracts C-9, C-14 and C-b. Tract conditions are very similar between Tracts C-14 and C-15.

Air.- The expected impact on air quality should be similar to that described for Tract C-9.

Vegetation.- Good grass and shrub sites occupy approximately 95 percent of this area. Only 5 percent of the tract is pinyon-juniper woodland. Effects on cover would be approximately the same as those described for Tract C-9.

Wildlife.- The impact on wildlife would be similar to that described for Tract C-9. Deer, bear, elk, bobcat, mountain lion, blue grouse, sage grouse, rabbits and raptors and numerous smaller animals and birds would be affected. Elk range over the tract during summer and winter and could be driven away.

Grazing.- The expected impacts would be similar to those described for Tract C-9. The same operators and herds range the area. The sheep operation would probably not be affected as the sheep do not range the area. The cattle operations, involving 5 operators, would be affected as described for Tract C-9.

Recreation.- The impact would be similar to that described for Tract C-9.

Cultural Features.- There are no significant cultural features on or near the tract that would be affected. General off-tract effects would be similar to those described for Tract C-b.

Minerals.- The oil shale resources that would be affected in the 30 gallons per ton category amount to approximately 230 thousand barrels per acre.

Archeological and Historical.- There is no evidence to indicate any effects on these resources should be anticipated; however, as the Ute Indians once inhabited the entire basin, possible impacts on artifacts may occur.

Socioeconomic.- The expected impact would be roughly similar to that described for Tract C-b.

13. COLORADO TRACT ALTERNATIVE C-16

Description

This tract lies southwest of Piceance Creek between Black Sulfur Creek and Big Jimmy Gulch (See Figure IX-15). Its legal description covers a total of 5,120 acres, consisting of the following lands:

T. 2 S., R. 98 W., 6th P.M., Rio Blanco Co., Colo.

Sections:	33	-	S½NE¼; S½
	34	-	All
	35	-	All

T. 3 S., R. 98 W., 6th P.M., Rio Blanco Co., Colo.

Sections:	2	-	Lots 1, 2, 3, 4; S½N½; S½
	3	-	Lots 1, 2, 3, 4; S½N½; S½
	4	-	Lots 1, 2, 3, 4; S½N½; S½
	5	-	S½NE¼; SE¼
	8	-	All
	9	-	All

The entire tract is public domain except for the following parcels which are patented with at least oil shale reserved to the United States. T. 2 S., R. 98 W., Sec. 33: NW¼SW¼; Sec. 35: SE¼SW¼; SE¼, SE¼; T. 3 S., R. 98 W., Sec. 2: NW¼, W½SW¼, SE¼SE¼; Sec. 3: E½SE¼. The entire tract is covered by 1 layer post-1920 placer mining claims except for the following lands: T. 2 S., R. 98 W., Sec. 33: SW¼, S½NE¼; Sec. 35: S½, SE¼NE¼; T. 3 S., R. 98 W., Sec. 2: E½SE¼, NW¼, W½SW¼; Sec. 3: SE¼; Sec. 5; S½NE¼.

Elevation.- Ranges from 6,500 feet to 7,000 feet above mean sea level.

Climate.- Average annual rainfall is 15 to 17 inches. Annual temperature range is -40°F to +95°F. Approximate mean temperature is 45°F.

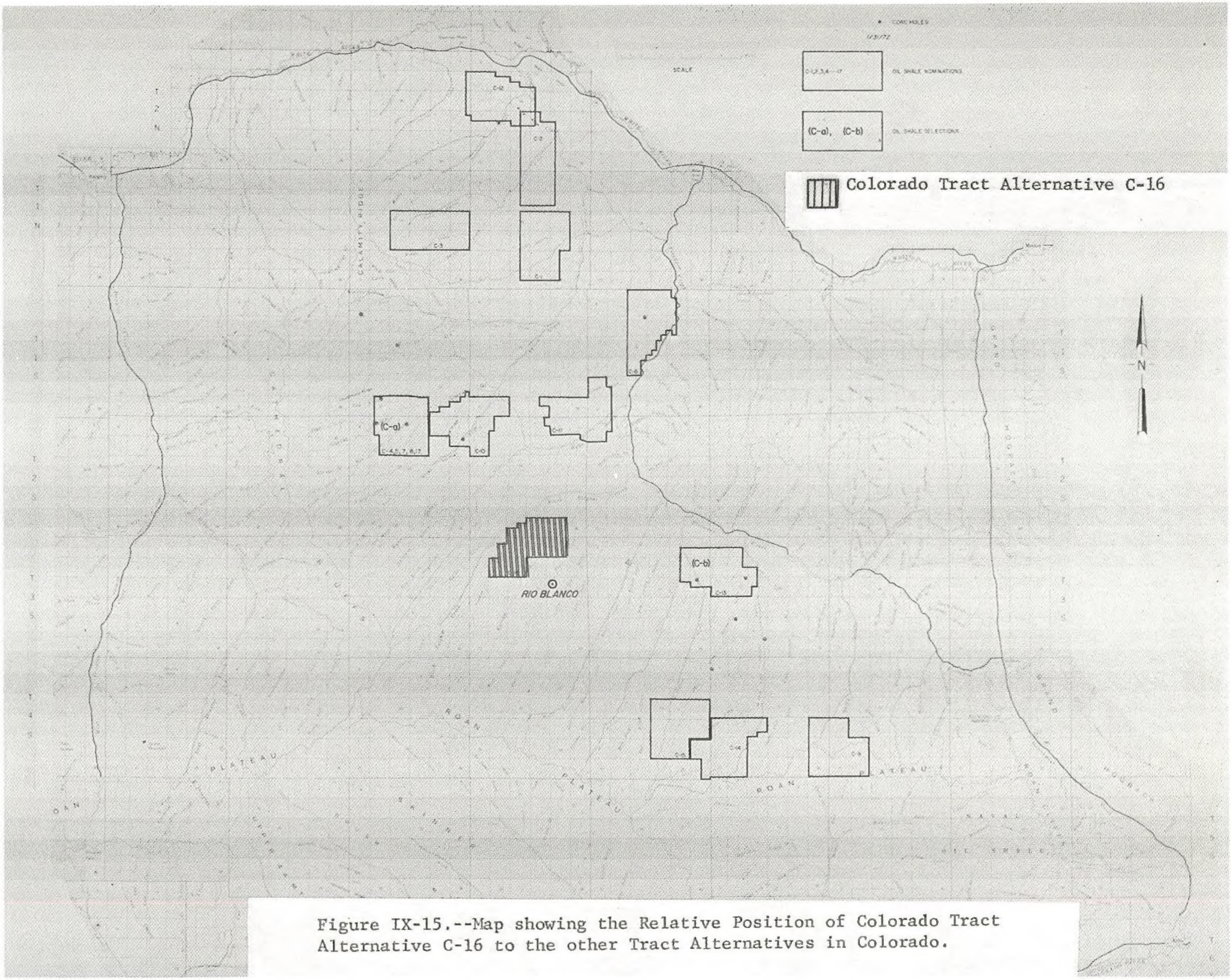

Figure IX-15.--Map showing the Relative Position of Colorado Tract Alternative C-16 to the other Tract Alternatives in Colorado.

Access.- There is a county maintained road in Black Sulfur Creek.

Vegetative Type.- Pinyon-juniper are at the higher elevations, big sagebrush are in drainage bottoms, with mountain browse interspersed throughout. Primary forage species are wheatgrasses, big sage, serviceberry, and bitterbrush.

Geologic Features:

(1) Alluvium.- Percent of area is 5 to 10 percent. Its composition consists of clay, silt, sand, and marlstone fragments, and has a thickness of 0 to 100 feet ±.

(2) Evacuation Creek Member of the Green River Formation.- Percent of area, 100 percent. Its composition consists mostly of sandstone and siltstone with minor amounts of marlstone, and has a thickness of 300 to 900 feet.

(a) Mineral Value.- Some zones contain appreciable quantities of analcime; also extractable alumina may be present.

(3) Parachute Creek Member of the Green River Foundation.- Percent of the area 100%, consists mostly of oil shale with some sandstone and thin beds of analcime. Contains nahcolite and dawsonite and in the northern part of the tract probably contains thin beds of halite. Thickness of member is approximately 1500 feet.

(4) Structure.- No faults mapped in the tract. The western end of a west-trending syncline bisects the tract. The rocks in the north one-half strike northeast and in the south one-half strike northwest. The dip is southeast at the rate of 1[illegible] feet per mile in the northern part of the area and northeast at the rate of 300 feet per mile in the southern part of the tract.

(5) Hydrology.- Hydrologic data are not available in this tract but are available from a test well drilled about one mile southward in Sec. 14, T. 3 S., R. 98 W. The electrical conductance of the ground water in the upper zone reached 800 umhos/cm, the transmissivity was 4,660 gpd/ft. In the lower zone, the conductance and the transmissivity probably are greater within Tract C-16.

(6) Mineral Value: 1/

(a) Mahogany Zone.- This area contains about 90 feet of shale averaging 30 gallons of oil per ton in units thicker than 10 feet with an in-place resource of about 180,000 barrels per acre.

(b) Lower Oil Shale Zone R-1 through R-6: (See Figure II-35, Chapter II, Volume I).- In the southern part of the tract, the section contains about 300 feet of shale averaging 30 gallons of oil per ton in units thicker than 10 feet with an in-place resource of about 600,000 barrels per acre. In the northern part of the tract, about 750 feet of section contains shale that averages 30 gallons of oil per ton in zones thicker than 10 feet with an in-place resource of 1,500,000 barrels per acre. Nahcolite is present throughout the tract. Zones containing nahcolite are thicker and more numerous in the northern part of the tract. About 500 feet of section contains dawsonite in the southern part of the tract and this interval thickens to more than 600 feet in the northern part.

A sequence of shale starting in the lower part of the Mahogany zone and extending downward 500 to 600 feet formerly contained saline minerals that have now been leached by ground water. The water, now

1/ Average approximately, but not less than 30 gallons/ton. Intervals greater than 10 feet thick and averaging less than 15 gallons/ton were not considered. This same criteria was used for all averaging of oil shale (gallon/ton) in this statement.

highly saline, occupies the voids created by leaching. This could present difficult mining problems in about 50 percent of the 30 gallon shale resource.

Air and Water Quality Characteristics:

(1) Surface Water Quality.- Surface water in intermittent drainages is of fair quality. That in perennial streams is poor to fair quality.

(2) Air Quality.- The tract's moderate elevation and position along the flank of the basin may subject discharges to concentration by nighttime drainage winds. General inversion conditions would be similar to those on Tract C-10.

Transportation Network:

(1) Roads.- Existing roads are described under "Access."

(2) Pipelines.- None in the vicinity.

Power Sources.- Power and telephones are available in Black Sulfur Creek at the north edge of the tract.

Land Use.- Present land use consists of livestock grazing and wildlife habitat.

Vegetation and Soils.- The drainage bottoms are characterized by deep, light-colored soils low in organic matters. These soils generally contain free salts in their profile and support stands of greasewood and other plants tolerant of these salts.

The ridges have a very shallow, light-colored soil over sandstones and shales. There are large inclusions of deep, dark loam soils on the exposures suitable for development of deeper soils.

Shallow soils support stands of pinyon-juniper with a sparse understory of perennial grasses and various shrubs. The deeper soils support heavy stands of sagebrush with understory of native grasses.

Plant Species:

(1) Browse

Amelanchier utahensis	Serviceberry
Purshia tridentata	Bitterbrush
Artemisia tridentata	Big sagebrush
Cercocarpus montanus	Mountain mahogany
Atriplex spp.	Saltbush
Chrysothamnus spp.	Rabbitbrush

(2) Grasses

Oryzopsis hymenoides	Indian ricegrass
Agropyron inerme	Beardless bluebunch wheatgrass
Koeleria cristata	Prairie junegrass
Poa spp.	Bluegrass
Elymus cinereus	Basin wildrye
Stipa comata	Needle and thread

(3) Trees

Pinus edulis	Pinyon pine
Juniperus osteosperma	Juniper
Quercus gambellii	Scrub oak

Vegetation Conditions.- Conditions are fair to good on vigor. The tract's adaptability to revegetation is limited by shallow soils on ridges and slopes.

Wildlife.- The tract serves as a spring, summer, and fall deer range and during the winter, the tract receives some utilization as an elk range. Deer, elk, bear, coyote, mountain lion, bobcat, blue grouse, sage grouse, rabbits, raptors, as well as numerous small bird and mammal species exist on the tract.

Activities associated with year-long livestock operations constitute the greatest activity on lands within the tract boundaries. Sport harvests and general recreational use, although somewhat restricted, results in considerable vehicular traffic.

Livestock Grazing.- Part of one allotment grazes cattle in spring and fall. 1700 cattle - approximately 500 AUM's on tract.

Improvements.- None of record.

Archeology.- None known or reported on the tract; however, it is known that the Ute Indians once inhabited the entire basin.

Recreation and Aesthetics.- The area is used primarily for hunting. Major values are wildlife uses.

Environmental Impact of Development

This tract is one of the more desirable tracts for underground mining and possibly in situ recovery. If underground mining were utilized to develop the resource, the following impacts would be likely:

Water.- The impacts on water supply and quality would be expected to approximate those described for Tract C-b. Surface water in the vicinity that could be affected include Fawn Creek, Hunter Creek, Black Sulfur Creek, Ryan Gulch Creek, and Upper Yellow Creek, and Piceance Creek. Most surface drainage in the tract vicinity is into Piceance Creek and that stream would receive the effects of any sedimentation or other quality degradation. About 11 springs and 2 wells within the possible influence zone would be affected. Extremely poor quality ground water would be anticipated which would cause waste management problems similar to those described for Tracts C-a and C-b.

Land.- The impact on the land surface would be similar to that described for Tract C-b.

Air.- The impact on air quality should be about as that described for Tract C-b.

Vegetation.- About 45 percent of the tract lands are sparsely vegetated or covered with pinyon-juniper. The remainder is brush land and grassland. The effects on this vegetation from development would be expected to approximate that described for Tract C-b.

Wildlife.- Some wildlife habitat lies at the less critical upper limits of the deer winter use zone and habitat losses resulting from development would therefore be less critical. An eagle nesting habitat is adjacent to the tract and would ultimately be displaced, and the eagles dispersed or reduced in population. Adverse effects of industrial penetration of habitat areas would occur for wildlife generally. These effects would approximate those described for Tract C-a.

Grazing.- One grazing allotment would be affected involving two operators, about 1,700 cattle grazing during the spring and fall months. Approximately 500 AUM's of forage utilization would be displaced elsewhere.

Recreation.- Deer and rabbit hunting and general recreation use of the area would decline. The area lies adjacent to a heavily traveled country road and additional road improvements and expanded traffic into the area would render the area less desirable for recreational uses.

Cultural Features.- Two unimproved jeep roads into the tract from northeast to southwest parallel the ridge topography and are utilized by hunters, recreationists, and woodcutters. Access to part of this route into the Cathedral Bluffs country could be blocked.

Minerals.- The minerals nahcolite and dawsonite are present on the tract in quantity and would be affected by development. The oil shale resources of 30 gallons per ton shale that would be affected by tract development average about 1,200 thousand barrels per acre.

Archeological and Historical.- Known historical use in the basin by the Ute Indian indicates the possibility of impact on artifacts and other archeological resources.

Socioeconomic.- The expected impact would approximate that described for Tract C-b.

14. Utah Tract Alternative U-1

Tract Alternative U-1.- This tract lies south of the White River and Asphalt Wash runs through the western portion of the tract (See Figure IX-16). The area of the tract comprises 5,120 acres consisting of the following lands:

<u>T. 11 S., R. 24 E., S.L.M., Uintah Co., Utah</u>

Sections: 4 - All
5 - All
6 - All
7 - All
8 - All
9 - All

<u>T. 10 S., R. 24 E., S.L.M., Uintah Co., Utah</u>

Section: 31 - All

*<u>T. 13 S., R. 24 E., S.L.M., Uintah Co., Utah</u>

Section: 7 - W½W½

*<u>T. 13 S., R. 23 E., S.L.M., Uintah Co., Utah</u>

Section: 12 - NE¼, E½NW¼, E½W½NW¼, E½NW¼SW¼, NE¼SW¼, NW¼SE¼, E½SE¼, E½SW¼SE¼.

The whole tract is public domain except for the following:

<u>T. 11 S., R. 24 E., S.L.M., Uintah Co., Utah</u>

Sections: 4 - S½SW¼, NW¼SW¼; Land patented but no minerals were reserved to the U. S.

6 - Approximately 49 acres patented lode claim in S½SE¼, NW¼SE¼, SE¼SW¼, N½SW¼; Lot 8, 46.43 acres Public Water Reserve.

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* This southern portion of the tract (approximately 500 acres) was excluded from evaluation since it is not adjacent to the larger portion of the tract and the distance between the two areas is considered to be too far for efficient operation.

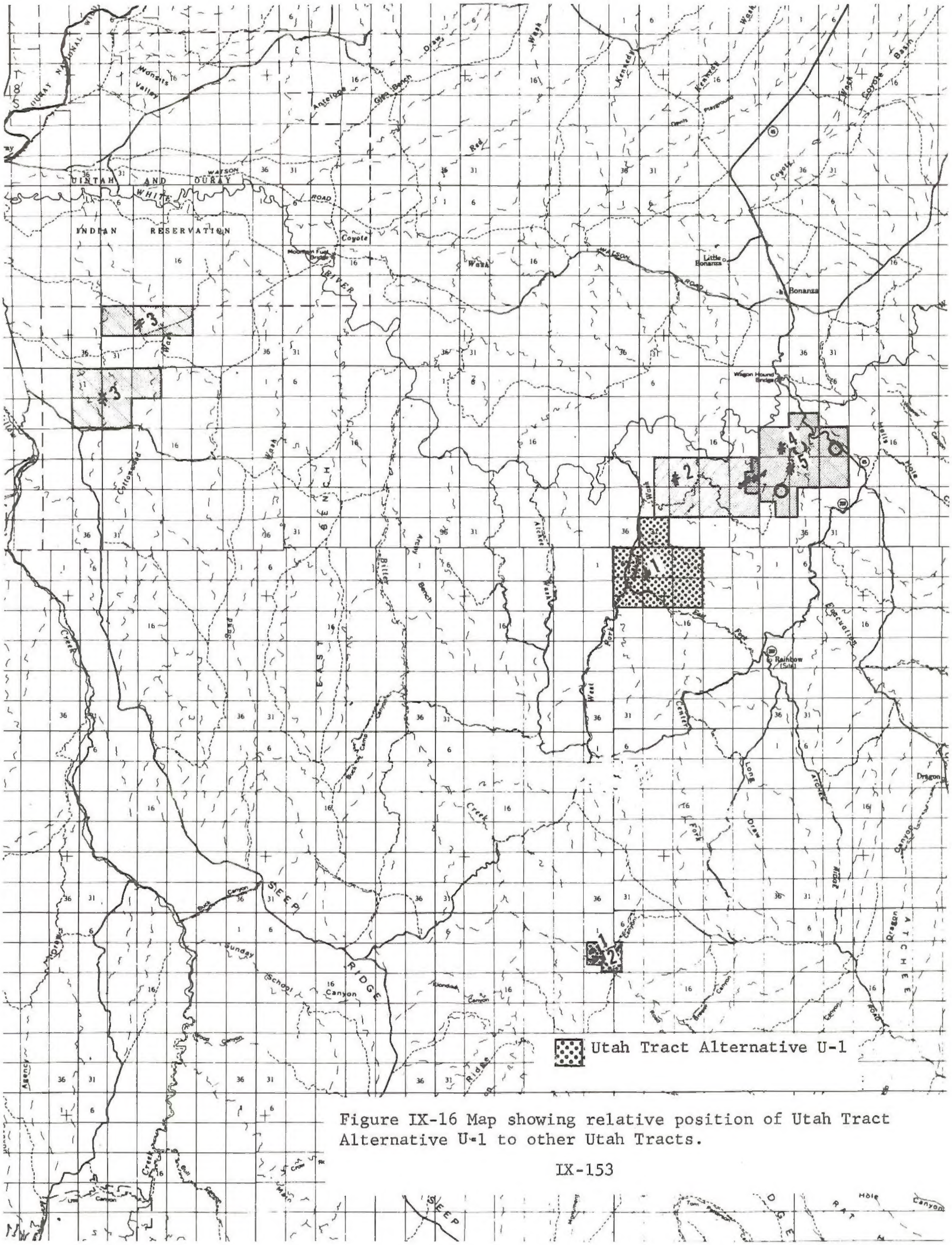

Figure IX-16 Map showing relative position of Utah Tract Alternative U-1 to other Utah Tracts.

T. 11 S., R. 24 E., S.L.M., Uintah Co., Utah (cont'd)

Sections: 7 - Approximately 49 acres patented lode claim in NE$\frac{1}{4}$NE$\frac{1}{4}$, S$\frac{1}{2}$NW$\frac{1}{4}$, NE$\frac{1}{4}$SW$\frac{1}{4}$, NW$\frac{1}{4}$SE$\frac{1}{4}$, E$\frac{1}{2}$SE$\frac{1}{4}$; Not 7, 26.86 acres Public Water Reserve.

8 - Approximately 52 acres patented lode claim in N$\frac{1}{2}$NW$\frac{1}{4}$, SE$\frac{1}{4}$NW$\frac{1}{4}$, E$\frac{1}{2}$NE$\frac{1}{4}$, SE$\frac{1}{4}$NE$\frac{1}{4}$, NE$\frac{1}{4}$SE$\frac{1}{4}$, S$\frac{1}{2}$SW$\frac{1}{4}$.

9 - Approximately 32 acres patented lode claim in NW$\frac{1}{4}$SW$\frac{1}{4}$, E$\frac{1}{2}$SW$\frac{1}{4}$, SW$\frac{1}{4}$SE$\frac{1}{4}$.

Utah State Selection applications cover all of Tract U-1 except 120 acres in SW$\frac{1}{4}$ sec. 4. The following mining claim conflicts exist:

T. 10 S., R. 24 E., S.L.M., Uintah Co., Utah

Section: 31 - Completely covered by both pre-1920 and post-1920 placer claims.

T. 11 S., R. 24 E., S.L.M., Uintah Co., Utah

Sections: 4 - N$\frac{1}{2}$) Completely covered by one or
and) more layers of post-1920 placer
9 - N$\frac{1}{2}$) claims.

Major portions of the remaining lands in T. 11 S., R. 24 E. are covered by lode claims.

Elevation.- Ranges from 5,200 to 5,900 feet above sea level.

Climate.- Average annual rainfall is 10 to 11 inches. The annual temperature ranges from -25°F to +105°F. Precipitation is fairly equally divided between winter snow and summer rain. Prevailing winds are from the southwest. The tract is subject to occasional severe summer thunderstorms and local flash floods.

Access.- Asphalt Wash Road, an unimproved BLM road, extends from Rainbow Road in sec. 1, T. 12 S., R. 23 E., to the White River, and runs in a north-south direction through the west side of the tract. A truck trail also cuts through the southwest corner of the tract.

Vegetative Type.- Approximately 80 percent of the tract is the pinyon-juniper vegetative type. The drainage bottoms are predominantly greasewood type; about 10 percent of the total area. The remaining 10 percent is sagebrush-bunch grass type.

Geologic Features.- The oil shales of primary interest occur in the Mahogany Zone. About 40 feet averages 30 gallons of oil per ton.[1/] The overburden above the Mahogany Zone ranges from 550 feet to 1,225 feet (the average is approximately 850 feet), and the nearest outcrop of the Mahogany Zone is about 3 miles to the southeast. Several gilsonite veins outcrop on the tract. One vein has a maximum width of approximately 30 inches and the other veins are appreciably narrower. The tract probably contains an insignificant amount of nahcolite in very thin lenses and pods in a stratigraphic sequence 300 to 500 feet above the Mahogany Zone.

Structure.- Strike of the rocks is to the east or northeast and dip to the north or northwest at the rate of 2^{o}. No significant faults are in the area but the Green River Formation is broken by a system of closely spaced joints.

Hydrology.- The wells in Utah tapping the Green River Formation commonly yield less water than those in Colorado. The water quality is highly variable. Insufficient data are available to rate the Utah tract by the criteria used for those in Colorado.

In sec. 6, T. 11 S., R. 24 E., a well drilled to a depth of 5,950 feet completely penetrated the Green River Formation at a

1/ Average approximately, but not less than 30 gallons/ton. Intervals greater than 10 feet thick and averaging less than 15 gallons/ton were not considered. This same criteria was used for all averaging of oil shale (gallon/ton) in this statement.

depth of 2,677 feet. Quality-of-water data from a sample of unknown depth indicate a dissolved solids content of 1180 mg/l. The test hole has since been converted to a water well.

A well drilled in sec. 8, T. 11 S., R. 24 W. was reported to yield 21 gpm from the Green River Formation at depths from 1,210 to 1,230 feet.

Air and Water Quality Characteristics:

(1) Surface Water Quality.- The area drains into the White River. The White River (near Watson, Utah) has essentially the same quality as it does upstream near Rangely.

(2) Air Quality.- Prevailing winds are southwesterly and, therefore, gaseous emissions would be transported toward Rangely, Colorado.

Transportation Network:

(1) Roads.- Existing roads are described under "Access." Existing roads can be improved without major relocation.

(2) Pipelines.- A major oil pipeline connecting the Rangely and Red Wash field to Salt Lake City is located about 6 miles north of the tract. A major gas line runs along Seep Ridge about 10 miles west of the tract.

Power Source.- There are existing power lines to Red Wash, Bonanza and water pumps at the White River Bridge. A major substation is located near Jensen, Utah, about 35 miles north of the tract.

<u>Land Use</u>.- Present land use consists of livestock grazing, wildlife habitat, recreation and gas production.

<u>Vegetation and Soils</u>.- Soils in this area are light colored, sodic, saline or sandy and highly erodable. The gradient and stability varies from very steep side slopes with stability problems to a modertely rolling topography with fairly stable soil characteristics. Soils of the upper slopes are shallow and immature with a thin A horizon.

In the lower reaches of the stream valleys, the soils are principally loamy, very fine and sand formed by alluvial deposits and outwash from the upper slopes.

Plant Species:

(1) <u>Browse</u>

Atriplex confertifolia	Shadscale
Artemisia nova	Black sage
Amelanchier utahensis	Serviceberry
Atriplex canescens	Four-wing saltbush
Eurotia lanata	Winterfat
Sarcobatus vermiculatus	Greasewood
Artemisia tridentata	Big sage

(2) <u>Grasses</u>

Poa fendleriana	Mutton grass
Oryzopsis hymenoides	Indian ricegrass
Stipa comata	Needle and thread
Agropyron inermi	Beardless bluebunch wheatgrass
Elymus cenereus	Wildrye
Poa spp.	Bluegrass

(3) <u>Trees</u>

Juniperus osteosperma	Juniper
Pinus edulis	Pinyon

Vegetative Conditions.- The tract is marginal for pinyon and juniper. Pinyon is a very small percent of the stand and is found only on the better areas. Juniper is low growing with very slow growth rate. Soil erosion is estimated at 0.38 to 0.45 acre-feet/ square mile.

Adaptability to Revegetation.- Revegetation of disturbed areas and waste piles will be difficult because of limited topsoil and limited precipitation.

Wildlife.- The tract supports a small resident mule deer herd. Other wildlife species using the tract include cottontail rabbits, chukar partridge, coyotes, bobcats, mountain lions, bear (occasional), golden eagle, prairie falcon, marsh hawk, sparrow hawk, redtail hawk, coopers hawk, and numerous other small bird and mammal species.

Livestock Grazing.- The tract is grazed by a band of 3,500 sheep for approximately 15 days in the winter or early spring and by another band of 1,800 sheep for approximately 30 days during the same period.

Improvements.- There are 3 water wells on the tract that flow into ponds providing valuable wildlife and livestock water.

Archeology.- There are no known archeological or historical features on the tract.

Recreation and Esthetics Present recreational use is principally hunting and sightseeing. Recreational visitor days are estimated at 50 per year. There are no developed recreation facilities on the tract.

The sharply cut, deep canyons, numerous buttes and spires, red and white rock formations, and dark-green juniper trees form scenic semidesert landscape.

Environmental Impact of Development

This tract is composed of 2 noncontiguous areas of land 13 miles apart. If underground mining is employed, which is feasible, the following impacts would be likely:

Water.- Effects should be approximately as described for Tracts U-a and W-a in earlier sections of this volume, although erosion effects would be low here, they would rapidly reach the White River. Among the 5 Utah tracts, erosion would be expected to be the greatest on U-1. The East and West Fork of Asphalt Wash and the White River would be directly affected. The Upper Bitter Creek drainage would be affected by development of the southern parcel. Two livestock reservoirs and 2 wells would be affected. If in situ processing was used, possible ground water contamination from organic and inorganic materials could be more significant here than with Tract W-a, due to proximity to the Green and White Rivers.

Land.- The impact would be similar to that described for Tract U-a. Road development linking the sub-tracts would increase area of surface disturbed.

Air.- The impact would be expected to be about as described for Tract U-a. Emissions would be carried toward Rangely, Colorado, approximately 26 miles northeast up the White River Valley. Bonanza is within range of possible plume effects.

Wildlife.- The area is critical winter deer range and receives year-round use by small game. Deer, rabbit, chukar partridge, predators, small birds and mammals would be affected with habitat

reduced and animals driven off. Bald eagles and prairie falcon exist in the area and would receive pressure on their habitat and foraging patterns, eventually driving them away. General effects would be similar to those described for Tract U-a.

Vegetation.- Consisting of pinyon-juniper woodland and sagebrush, greasewood brush types largely, the impact expected would be similar to that described for Tract U-a.

Grazing.- Approximately 3,500 sheep winter range over the tract. Two operators are involved. Operations would probably have to be removed from the area.

Recreation.- The area sustains 50-60 hunter days of use annually which would be nearly eliminated.

Cultural Features.- Existing dirt roads are through roads to other areas south and east. Development could affect transportation through these corridors. Some roads would be upgraded. Oil and gas pipelines in the northern part of the larger parcel could be affected.

Minerals.- Gilsonite mines in the area indicate some potential for this mineral on the tract and those resources could be affected. Oil shale resources are unestimated. A 40 foot thickness of oil shale in the Mahogany Zone averaging 30 gallons of oil per ton that contains 80,000 bbl of oil per acre would be affected.

Archeological and Historical.- No evidence of archeological resources are known but the general area is rich in Indian hunting cultures, and the possibility exists that artifacts may be affected.

Socioeconomic.- The impact would be similar to that described for Tract U-a.

If in situ mining was employed on this tract, the effects would be expected to be similar to those described for Tract U-a in Sections A through G, Chapter IV, of this volume.

15. Utah Tract Alternative U-2

Description

Tract Alternative U-2.- This tract lies just south of the White River and adjacent to and west of Tracts U-4 & 5 (U-b) (See Figure IX-17). This tract is known as U-a in this Environmental Impact Statement. Its legal description covers a total of 5,120 acres, consisting of the following lands:

T. 10 S., R. 24 E., S.L.M., Uintah Co., Utah

Sections:
- 20 - All
- 21 - All
- 22 - All
- 27 - All
- 28 - All
- 29 - All
- 19 - E½
- 30 - E½

All land in this site is public domain covered by Utah State Selection Applications excluding W½ sec. 12, T. 13 S., R. 23 E., which is patented with no mineral reserved. The following lands are covered by mining claims:

T. 10 S., R. 24 E., S.L.M., Uintah Co., Utah

Sections:
- 22 - covered by pre-1920 placer claims
- 27 - covered by pre-1920 placer claims
- 19 - covered by post-1920 placer claims
- 20 - covered by post-1920 placer claims
- 29 - covered by post-1920 placer claims
- 30 - covered by post-1920 placer claims

Elevation.- Ranges from 4,600 to 5,860 feet above sea level.

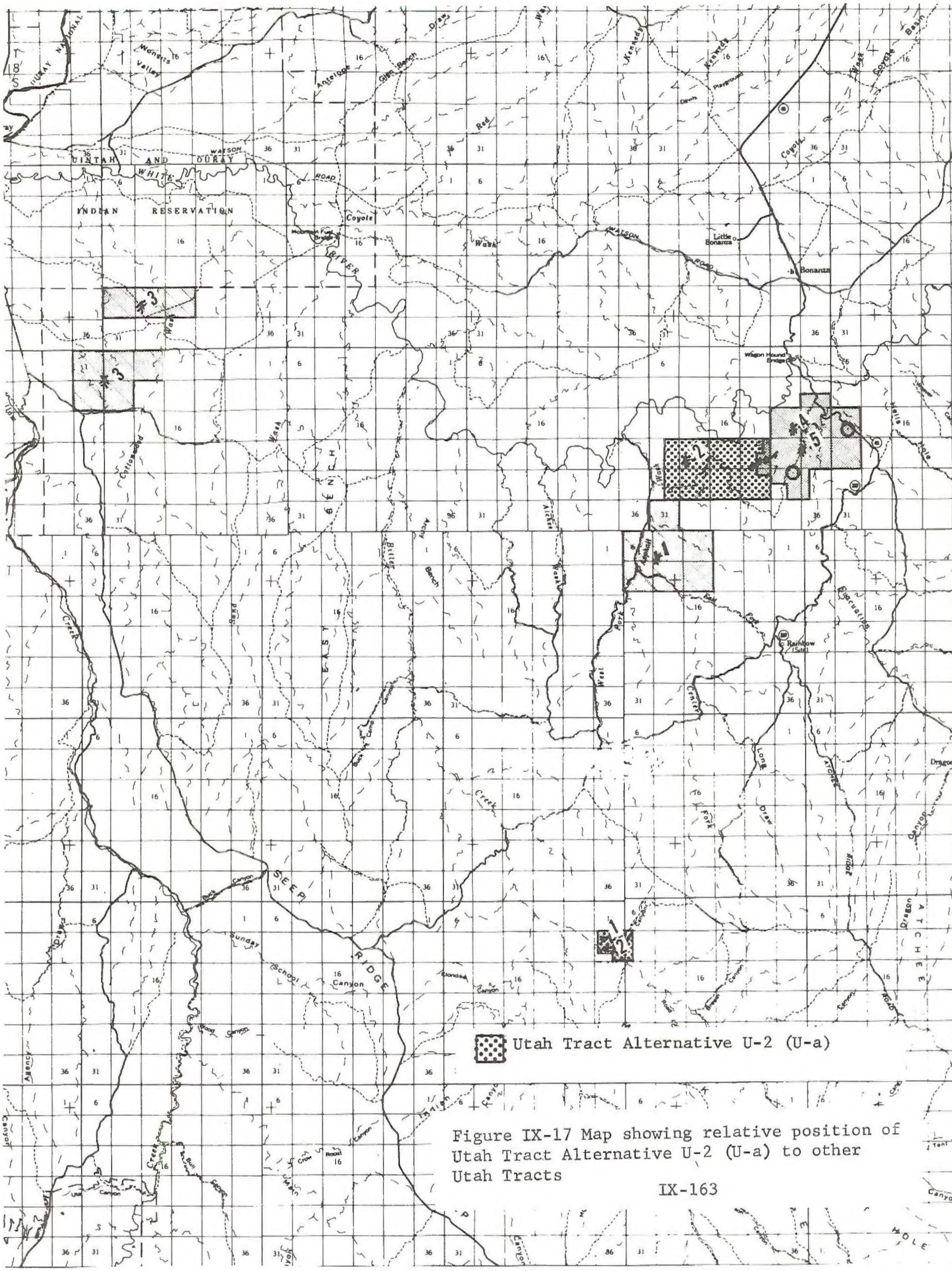

Figure IX-17 Map showing relative position of Utah Tract Alternative U-2 (U-a) to other Utah Tracts

Climate.- Average annual rainfall is 10 to 11 inches. The annual temperature ranges from -25°F to +105°F. Precipitation is fairly equally divided between winter snow and summer rain. Prevailing winds are from the southwest. The tract is subject to occasional severe summer thunderstorms and local flash floods.

Access.- State Highway 45 is paved from U.S. 40 to Bonanza. An improved, unsurfaced road continues southward across White River to Dragon and on into Colorado through T. 12 S., R. 25 E. An unimproved road commences at the aforementioned unsurfaced road in sec. 12, T. 10 S., R. 24 E. and runs through the tract to Asphalt Wash Road at the western edge of the tract.

Vegetative Type.- Approximately 85 percent of the tract is pinyon-juniper. The drainage bottoms contain some greasewood types (5 to 10 percent of total area) and occasional sagebrush types occur (5 to 10 percent of total area) on the tract.

Geologic Features.- This tract is located immediately south of White River near the eastern edge of Uinta Basin. Within the tract, the oil shales of primary interest occur in the Mahogany Zone. The overburden above the Mahogany Zone ranges from 550 to 1,225 feet, an average of approximately 850 feet. The nearest outcrop of the Mahogany Zone lies about 4 miles east of the tract. A minor amount of nahcolite probably is present in the tract in thin lenses and pods in a sequence 300 to 500 feet above the Mahogany.

The core holes nearest to this tract are those drilled in Tracts 4 and 5. The available information indicates that

thirty gallon per ton shale within this sequence is about 45 feet thick. 1/

Structure.- Strike of the rocks is to the east or northeast and dip to the north or northwest at the rate of 2°F. No significant faults are in the area, but the Green River Formation is broken by a system of closely spaced joints.

Hydrology.- Very little ground water data is available. One well in the vicinity of the tract reported "fresh" water at 600 feet. Conditions are probably similar to those of Tract U-1.

In sec. 6, T. 11 S., R. 24 E., a well drilled to a depth of 5,950 feet completely penetrated the Green River Formation at a depth of 2,677 feet. Quality-of-water data from a sample of unknown depth indicate a dissolved solids content of 1,180 mg/l. The test hole has since been converted to a water well.

A well drilled in sec. 8, T. 11 S., R. 24 W. was reported to yield 21 gpm from the Green River Formation at depths from 1,210 to 1,230 feet.

Air and Water Quality Characteristics:

(1) Surface Water Quality.- The area drains into the White River. The White River (near Watson, Utah) has essentially the same quality as it does upstream near Rangely.

(2) Air Quality.- Prevailing winds are southwesterly and, therefore, gaseous emissions would be transported toward Rangely, Colorado.

1/ Average approximately, but not less than 30 gallons/ton. Intervals greater than 10 feet thick and averaging less than 15 gallons/ton were not considered. This same criteria was used for all averaging of oil shale (gallon/ton) in this statement.

Transportation Network:

(1) Roads.- Existing roads are described under "Access." They could be improved without major relocation; however, an oil shale industry may require a new road system.

(2) Pipelines.- A major oil pipeline connecting the Rangely and Red Wash field to Salt Lake City is located about 6 miles north of the tract. A major gas line runs along Seep Ridge about 10 miles west of the tract.

(3) Power Source.- Existing power lines to Red Wash, Bonanza, and the water pumps at the White River bridge are probably inadequate for an oil shale plant in addition to their present load. A major substation is located near Jensen, Utah, about 25 miles north of the tract.

Land Use.- Present land use consists of livestock grazing, wildlife habitat, recreation and gas production.

Vegetation and Soils.- Soils in this area are light colored, sodic, saline or sandy and highly erodable. The gradient and stability varies from very steep side slopes with stability problems to a moderately rolling topography with fairly stable soil characteristics. Soils of the upper slopes are shallow and immature with a thin A horizon.

Plant Species:

(1) Browse

Atriplex confertifolia	Shadscale
Artemisia nova	Black sage
Amelanchier utahensis	Serviceberry
Artemisia tridentata	Big sage
Atriplex canescens	Four-wing saltbush
Eurotia lanata	Winterfat
Sarcobatus vermiculatus	Greasewood

(2) Grasses	Comman Name
Poa fendleriana	Mutton grass
Oryzopsis hymenoides	Indian ricegrass
Stipa comata	Needle and thread
Agropyron inermi	Beardless bluebunch
Elymus cenereus	Wildrye
Poa spp.	Bluegrass

(3) Trees	
Juniperus osteosperma	Juniper
Pinus edulis	Pinyon

Vegetation Conditions.- The tract is marginal for pinyon and juniper. Pinyon constitutes a very small percentage of the stand and is found only on the better areas. Juniper is low growing with very slow growth rate. Soil erosion is estimated at 0.38 to 0.45 acre-feet/square mile.

Adaptability to Revegetation.- Revegetation of disturbed areas and waste piles will be difficult because of limited topsoil and limited precipitation.

Wildlife.- The tract supports a small resident mule deer herd. Other wildlife species using the site include cottontail rabbits, chukar partridge, coyotes, bobcats, mountain lions, bear (occasional), golden eagle, prairie falcon, marsh hawk, sparrow hawk, redtail hawk, and coopers hawk, and numerous small bird. Several small herds of wild horses range outward from the Book Cliff Mountains, but none have been observed on or near the tract.

Livestock Grazing.- The tract is grazed by a band of 1,400 sheep for approximately 40 days in the winter or early spring.

Improvements.- Small stock water reservoir.

Archeology.- There are no known archeological or historical features on the tract.

Recreation and Aesthetics.- Present recreational use is principally hunting and sightseeing. Recreational visitor days are estimated at 50 per year. There are no developed recreation facilities on the tract.

The sharply cut, deep canyons, numerous buttes and spires, red and white rock formations, and dark-green juniper trees form a scenic semidesert landscape.

Environmental Impact of Development

Tract U-2 is designated as Tract U-a in this proposal. The environmental effects of development have been described in Sections A through G, Chapter IV of this volume. Like U-1, it involves 2 noncontiguous parcels about 13 miles apart south of the White River Valley and east of Seep Ridge, Uintah County.

The only additional notation would be:

The impact on associated mineral resources is unknown. No minerals are reported on tract. A 45 foot thickness of oil shale in the Mahogany Zone averaging 30 gallons of oil per ton that contains 90,000 barrels of oil per acre would be affected.

16. UTAH TRACT ALTERNATIVE U-3

Description

Tract Alternative U-3.- This tract is located about 2 miles southeast of Ouray, Utah, in the east-central part of the Uinta Basin (See Figure IX-18). Its legal description covers a total of 5,120 acres, consisting of the following lands:

T. 9 S., R. 21 E., S.L.M., Uintah Co., Utah

Sections: 28 - All
29 - All
30 - All

T. 10 S., R. 21 E., S.L.M., Uintah Co., Utah

Sections: 5 - All
6 - All
7 - All

T. 10 S., R. 20 E., S.L.M., Uintah Co., Utah

Sections: 1 - All
12 - All

The entire tract is public domain. There are no post-1920 placer claims on this tract. The only pre-1920 placer claims lie on the portion of the tract within T. 9 S., R. 21 E. These are the Kuhnhill Oil Nos: 5 - 16 of unknown ownership.

Elevation.- Ranges from 4,800 feet to 5,200 feet above sea level.

Climate.- Average annual rainfall is 10 to 11 inches. The temperature ranges from -25°F to +105°F. Precipitation is fairly equally divided between winter snow and summer rain. Prevailing winds are from the southwest. The tract is subject to occasional severe summer thunderstorms and local flash floods.

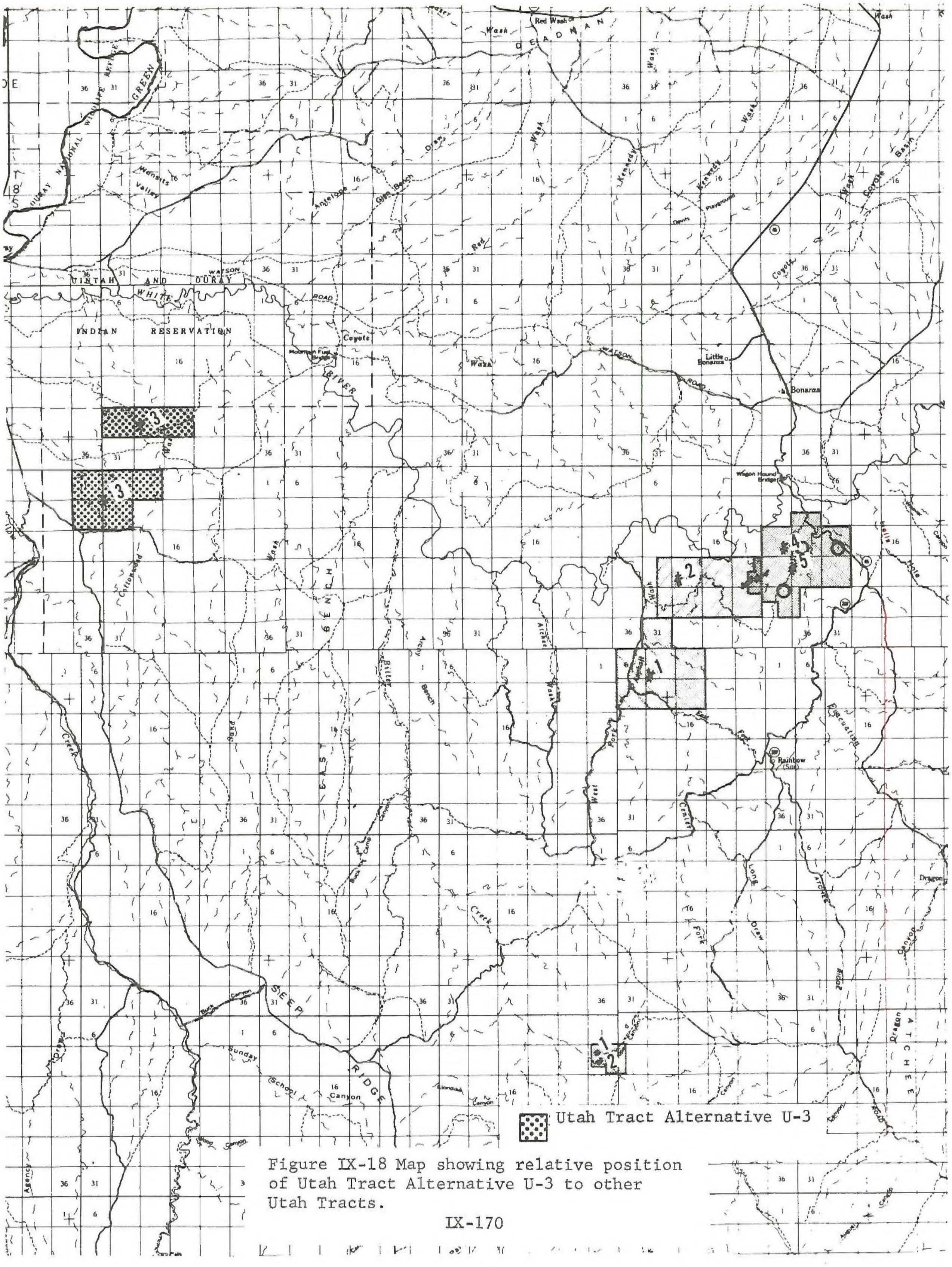

Figure IX-18 Map showing relative position of Utah Tract Alternative U-3 to other Utah Tracts.

Access.- The improved unsurfaced county road running from Ouray to P. R. Spring passes through the southwest corner of the tract. A few unimproved truck trails extend into the tract.

Vegetative Type.- The south portion is almost entirely mixed desert shrub type. The north portion is mixed desert shrub with minor areas of sagebrush.

Geologic Features.- The oil shales that average approximately 30 gallons per ton are about 25 feet in the Mahogany Zone. Overburden above the Mahogany Zone ranges from 2,000 to 2,550 feet and the average is approximately 2,300 feet. The nearest outcrop of the Mahogany Zone is about 15 miles to the south. Several gilsonite veins crop out in the tract and the widest of these has a width of about 36 inches. The amount of nahcolite on the tract is probably minor. It occurs as thin lenses and pods in a sequence 300 to 600 feet about the Mahogany Zone.

Structure.- The faults are not significant. The rocks strike east or northeast. The dip is to the north or northwest at a rate of 2^{o}.

Hydrology.- Best hydrologic data below the Mahogany Zone are derived from a test well drilled in sec. 36, T. 9 S., R. 20 E. A drill stem test of the interval from 2,729 to 2,809 feet, and 2,901 to 2,929 feet showed a yield of 8 gpm, an electrical conductance of 82,000 umhos/cm, and a transmissivity of about 10 gpd/ft. A test of the interval from 3,115 to 3,154 feet indicates a yield of 16 gpm, an electrical conductance of 48,000 umhos/cm and a transmissivity of 18 gpd/ft. The conductance of the water is unusually high, but the amount of water present seems to be negligible.

Air and Water Quality Characteristics:

(1) Surface Water Quality.- Near this tract, the quality of the White River is significantly lower than at Rangely, Colorado, with increased salinity because of the higher sulfate, and dissolved solids content.

(2) Air Quality.- The relatively isolated location suggests less impact on populated areas caused by prevailing winds but the proximity to the Ute Indian Reservation could negate this advantage. Limited information is available about the air quality of the tract.

Transportation Network:

(1) Roads.- Existing roads are described under "Access." They can be improved without major relocation; however, development of the tract for shale oil recovery would probably involve consideration of a new road system.

(2) Pipelines.- A major oil pipeline connecting the Rangely and Red Wash field to Salt Lake City is located about 6 miles north of the tract. Seepridge Gas Line passes near the southwest corner of the tract.

Power Sources.- Existing power lines to Red Wash, Bonanza, and the water pumps at the White River bridge are probably inadequate for an oil shale plant in addition to their present land. A major substation is located near Jensen, Utah.

Land Use.- Present land use consists of livestock grazing, wildlife habitat, recreation and gas production.

Vegetation and Soils.- Soils on Tract U-3 contain considerably more clay than those on Tract U-1. Mixed desert shrub types on this tract are predominantly saltbush. The stands are sparse and include a fair amount of matt saltbush and prickly pear cactus in addition to the species enumerated for Tract U-1.

Plant Species:

(1) Browse

Tetrademia spinescens	Horsebrush
Atriplex corrigata	Matt saltsage
Atriplex canescens	Four-wing saltbush
Artemisia nova	Black sage
Artemisia spenescens	Bud sage
Atriplex confertifolia	Shadscale

(2) Grasses

Hilaria jamesii	Galleta (curly grass)
Oryzopsis hymenoides	Indian ricegrass
Stipa comata	Needle and thread
Bromus tectorum	Cheatgrass
Agropyrom smithii	Western wheatgrass
Elymus cenereus	Basin wildrye

(3) Trees

None

Vegetation Conditions.- The tract is marginal for pinyon and juniper. Pinyon is a very small percentage of the stand and is found only on the better areas. Juniper is low growing with very slow growth rate. Soil erosion is estimated at 0.38 to 0.45 acre-feet/square mile.

Adaptability to Revegetation.- Revegetation of disturbed areas and waste piles will be difficult because of limited topsoil and limited precipitation.

Wildlife.- Deer, rabbit, mountain lion, coyote, bobcat, chukar, raptors, hawks, falcons and eagles plus numerous small bird and mammal species exist on the tract. Prairie dogs are present on Tract U-3. Mule deer use is light; mostly restricted to White River Canyon and Cottonwood Wash.

Livestock Grazing.- Approximately 4,700 sheep graze this tract in the winter for a total of 20 days.

Improvements.- Three small stock water reservoirs, several gas wells, and gaslines.

Environmental Impact of Development

This tract consists of two noncontiguous parcels about one mile apart south of the Uinta and Ouray Indian Reservation and 5 miles southeast of the confluence of the White and Green Rivers. In situ development appears to be the preferred method for developing this tract. If developed with this method, the following impacts appear likely:

Water.- The impact would be similar to that described for Tracts U-a and W-a for in situ processing. The tract is drained by both the White and Green Rivers and effects on both rivers are possible.

Land.- This impact would be approximately the same as described for Tracts U-a and U-b.

Air.- This impact would be similar to that described for Tract U-a except effects on Rangely, Colorado would be less noticeable. Also, the Uinta and Ouray Indian Reservation would receive H_2/SO_2 odors from a plant sited on this tract.

Vegetation.- This impact would be more heavy on sagebrush and salt brush but otherwise about the same as that described for Tract U-a.

Wildlife.- The only critical wildlife habitat on this tract is for raptors and small game species; chukar partridge, rabbit, eagles, falcons, and hawks. Otherwise effects would be about as described for Tract U-a including the bald eagle and prairie falcons and their habitat.

Recreation.- The impact would be similar to that described for Tract U-1, about 60 hunter days per year would be affected with some reduction. Sightseeing, hunting and general use predominate over the area and would be reduced.

Grazing.- It is likely that grazing would be ultimately eliminated by development on this tract. Winter sheep use predominates. One operator would be affected.

Cultural Features.- Gas wells are nearby, and pipelines in the vicinity traverse this tract. It is possible trail development could come in conflict with these facilities. One stock reservoir exist on tract that might become inoperable.

Minerals.-1/ Associated minerals occur only in minor amounts. The effect on resources would be mainly on oil shales. This resource is not estimated for the tract. The beds average 25 feet thick for 30 gallons per ton shale.

1/ Average approximately, but not less than 30 gallons/ton. Intervals greater than 10 feet thick and averaging less than 15 gallons/ton were not considered. This same criteria was used for all averaging of oil shale (gallon/ton) in this statement.

Archeological and Historical.- Same as for Tract U-a.

Socioeconomic.- This impact would be similar to that described for Tract U-a. However, the tract's proximity to the Ute Indian Reservation may offer the potential for direct economic impacts.

17. UTAH TRACT ALTERNATIVES U-4 AND U-5

Description

Tract Alternatives U-4 and U-5.- These two tracts, which have identical boundaries, are located immediately south of the White River near the eastern edge of the Uinta Basin (See Figure IX-19). These tracts are listed as U-b in the Environmental Impact Statement. The legal description of the tracts is as follows:

T. 10 S., R. 25 E., S.L.M., Uintah County, Utah.

Sections: 18 - All
19 - All

T. 10 S., R. 24 E., S.L.M., Uintah County, Utah.

Sections: 12 - S 1/2
13 - All
14 - All
22 - E 1/2 NE 1/4; SE 1/4
23 - All
24 - All
25 - W 1/2 W 1/2
26 - E 1/2; NW 1/4
27 - N 1/2 NE 1/4

Total -- 5.120 acres

All lands of the tracts are public domain except NW 1/4 NW 1/4 Sec. 14, T. 10 S., R. 24 E., SLM, which is patented with oil and gas and oil shale reserved. The entire tract is covered by Utah State Selection Applications. The following mining claim conflicts exist: T. 10 S., R. 24 E,; Secs. 13, 14, 23, 24, and 26; T. 10 S., R. 25 E.; Secs. 18 and 19. All are covered by post-1920 placer claims. T. 10 S. R. 24 E.: Secs. 12, 13, 14, 23, and 24; T. 10 S., R. 25 E.: Secs. 18 and 19. These also contain lode claims of unknown ownership.

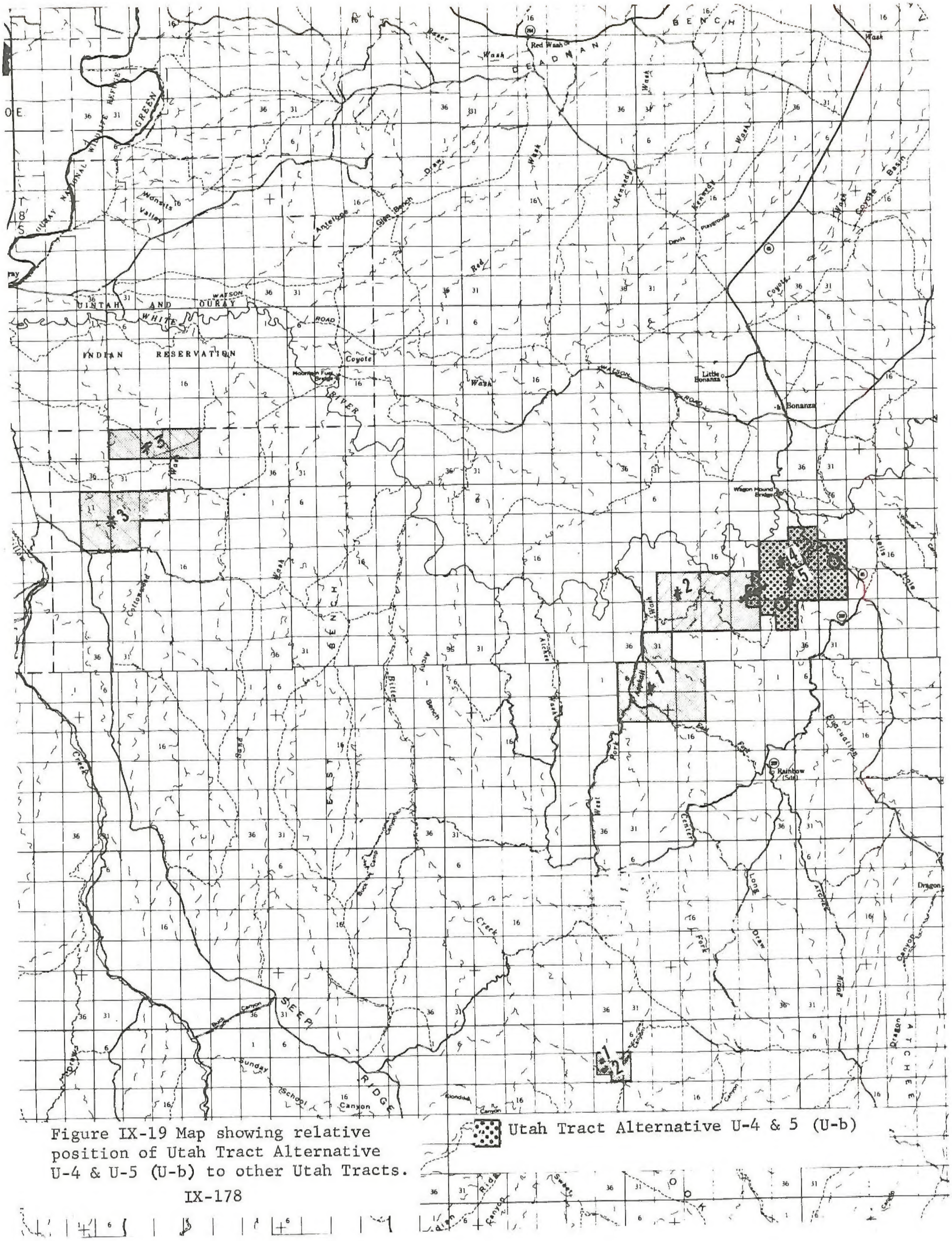

Figure IX-19 Map showing relative position of Utah Tract Alternative U-4 & U-5 (U-b) to other Utah Tracts.

The entire tract is covered by multiple layers of pre-1920 placer claims.

Elevation.- The elevation ranges from 5,000-5,800 feet above sea level.

Climate.- 10"-11" rainfall -25°F to +105°F temperature range. Precipitation is fairly equally divided between winter snow and summer rain. Prevailing winds are from the southwest. The site is subject to occasional severe summer thunderstorms and local flash floods.

Access.- State Highway 45 is paved from U.S. 40 to Bonanza. An improved, unsurfaced road continues southward across White River to Dragon and on into Colorado through T. 12 S., R. 25 E. An unimproved road commences at the aforementioned unsurfaced road in Sec. 12, T. 10 S., R. 24 E., and runs through the tract to Asphalt Wash Road at the western edge of the tract.

Vegetative Type.- Approximately 85% of the tract is pinyon-juniper. The drainage bottoms contain some greasewood types (5% to 10% of total area) and occasional sagebrush types occur (5% to 10% of total area).

Geologic Features: 1/

Within the tracts the oil shales of primary interest occur in the Mahogany zone in beds that dip gently westward to northwestward at about 2° to 4°. The overburden above the Mahogany zone ranges from 300 feet to 1,375 feet and the average is approximately 700 feet. Oil Shale averaging 30 gallons of oil per ton is about 50 feet thick. The nearest outcrop of the Mahogany zone

1/ Average approximately, but not less than 30 gallons/ton. Intervals greater than 10 feet thick and averaging less than 15 gallons/ton were not considered. This same criteria was used for all averaging of oil shale (gallon/ton) in this statement.

lies about 0.8 mile east of the tracts. One narrow gilsonite vein (2 inches thick) outcrops in the west-central part of the tracts. The minor amount of nahcolite found in the tracts occurs as very thin lenses and small pods in the stratigraphic sequence extending from 300-500 feet above the Mahogany Zone.

Structure.- Strike of the rocks is to the east or northeast and dip to the north or northwest at the rate of 2°. No significant faults are in the area, but the Green River Formation is broken by a system of closely spaced joints.

Hydrology.- A test well drilled in Sec. 18, T. 10 S., R. 25 E. reportedly encountered "fresh" ground water at a depth of 600 feet in the Green River Formation. Ground water conditions are probably similar to those of Tract U-1 which were found to be as follows: In Sec. 6, T. 11 S., R. 24 E. a well drilled to a depth of 5,950 feet completely penetrated the Green River Formation at a depth of 2,677 feet. Quality-of-water data from a sample of unknown depth indicate a dissolved solids content of 1180 mg/1. The test hole has since been converted to a water well.

A well drilled in Sec. 8, T. 11 S., R. 24 W. was reported to yield 21 gpm from the Green River Formation at depths from 1,210 to 1,230 feet.

Air and Water Quality Characteristics:

(1) Surface Water Quality.- Area drains into the White River (near Watson, Utah) has essentially the same quality as it does upstream near Rangely.

(2) Air Quality.- Prevailing winds are southwesterly and, therefore, gaseous emissions would be transported toward Rangely, Colorado.

Transportation:

(1) Roads.- Existing roads are described under "Access," and could be improved without major relocation; however, an oil-shale industry may require a new road system.

(2) Pipelines.- A major oil pipeline connecting the Rangely and Red Wash field to Salt Lake City is located about 6 miles north of the Tract. A major gas line runs along Seep Ridge about 10 miles west of the Tract.

Power Source.- Existing power lines to Red Wash, Bonanza and the water pumps at the White River bridge are probably inadequate for an oil-shale plant in addition to their present load. A major substation is located near Jensen, Utah, about 35 miles north of the Tract.

Land Use.- Present land use consists of livestock grazing, wildlife habitat, recreation and gas production.

Vegetation and Soils.- Soils in this area are light colored, sodic, saline or sandy and highly erodable. The gradient and stability varies from very steep side slopes with stability problems to a moderately rolling topography with fairly stable soil characteristics. Soils of the upper slopes are shallow and immature with a thin A-horizon.

In the lower reaches of the stream valleys, the soils are principally loamy, very fine sand formed by alluvial deposits and outwash from the upper slopes.

Plant Species:

(1) Browse

Atriplex confertifolia	Shadscale
Artemisis nova	Black sage
Amelanchier utahensis	Serviceberry
Artemisia tridentata	Big Sage
Atriplex canescans	Four-wing saltbush
Eurotia lanata	Winterfat
Sarcobatus vermiculatus	Greasewood

(2) Grasses

Poa fendlariana	Mutton grass
Oryzopsia hymenoides	Indian ricegrass
Stipa comata	Needle and thread
Agropyron inermi	Beardless bluebunch wheatgrass
Elymus cenereus	Wildrye
Poa spp.	Bluegrass

(3) Trees

Juniperus osteosperma	Juniper
Pinus etolis	Pinyon

(1) The pinyon-juniper type consists of about 75% trees and shrubs with a 15% bunchgrass and 10% forb understory.

(2) The mixed desert shrub type consists of about 25% low-growing, salt-tolerant shrubs, 50% bunch grasses, and 25% forbs.

(3) The greasewood types are generally dense stands of greasewood with very few other shrubs and little understory. Plant composition is typically approximately 90% shrubs, 6% grass, and 4% forbs.

(4) The sagebrush types are typically about 60% brush, 30% grass, and 10% forbs. Big sage and curly grass (Hilaria species) are the predominant species.

Vegetative Conditions.- The tract is marginal for pinyon and juniper. Pinyon constitutes a very small percent of

the stand and is found only on the better areas. Juniper is low growing with very slow growth rate. Soil erosion is estimated at 0.38 to 0.45 acre feet/square mile. Revegetation of disturbed areas and waste piles will be difficult because of limited top-soil and limited precipitation.

Wildlife.- The tract supports a small resident mule-deer herd. Other wildlife species using the tract include cotton-tail rabbits, chukar partridge, coyotes, bobcats, mountain lions, bear (occasional), golden eagle, prairie falcon, marsh hawk, sparrow hawk, redtail hawk, and coopers hawk and numerous small birds and mammal species.

Several small herds of wild horses range outward from the Book Cliff Mountains, but none have been observed on or near the tract.

Archeaology.- There are no known archaeological or historical features on the tract.

Recreation and Esthetics.- Present recreational use is principally hunting and sightseeing. Recreational visitor days are estimated at 50 per year. There are no developed recreation facilities on the tract.

The sharply cut, deep canyons, numerous buttes and spires, red and white rock formations, and dark-green juniper trees form a scenic semidesert landscape.

Livestock Grazing.- Approximately 1,400 sheep graze this tract for about 40 days in winter and early spring.

Improvements.- A small stock water reservoir is located on the tract.

Environmental Impact of Development U-4 and U-5

These two tracts are identical land areas and constitute Tract U-b in the prototype program. The effects of development have been described in Sections A through G, Chapter IV in this volume.

The only additional notation would be:

Scattered gilsonite veins exists in mineral resources of the tract and could be affected. A 50 foot thickness of oil shale in the Mahogany Zone averaging 30 gallons of oil per ton that contains 100,000 barrels of oil per acre would be affected.

18. WYOMING TRACT ALTERNATIVES W-1, W-2 AND W-3

Description

These tracts lay adjacent to each other and Tracts W-1 and W-2 comprise Tracts W-a and W-b covered in this Environmental Impact Statement (See Figure IX-20, 21, 22). The tracts are located on the southwestern flank of the Washakie Basin and include part of the Kinney Rim in southern Wyoming. The legal description of all tracts consist of the following land:

Tract No. W-1

T. 14 N., R. 99 W., 6th P.M., Sweetwater County, Wyo.

Sections:
17 - All
18 - All
19 - NW¼
20 - All
21 - All
22 - All
27 - All
28 - All
29 - N½; SE¼

Tract No. W-2

T. 13 N., R. 99 W., 6th P.M., Sweetwater County, Wyo.

Sections:
1 - S½; S½N½; Lots 1, 3, 4
2 - All
3 - All
4 - Lot 1, SE¼NE¼
10 - E½; E½NW¼
11 - All
12 - All

T. 14 N., R. 99 W., 6th P.M., Sweetwater County, Wyo.

Sections:
33 - E½E½
34 - All
35 - All

Total - 5,083.24 acres

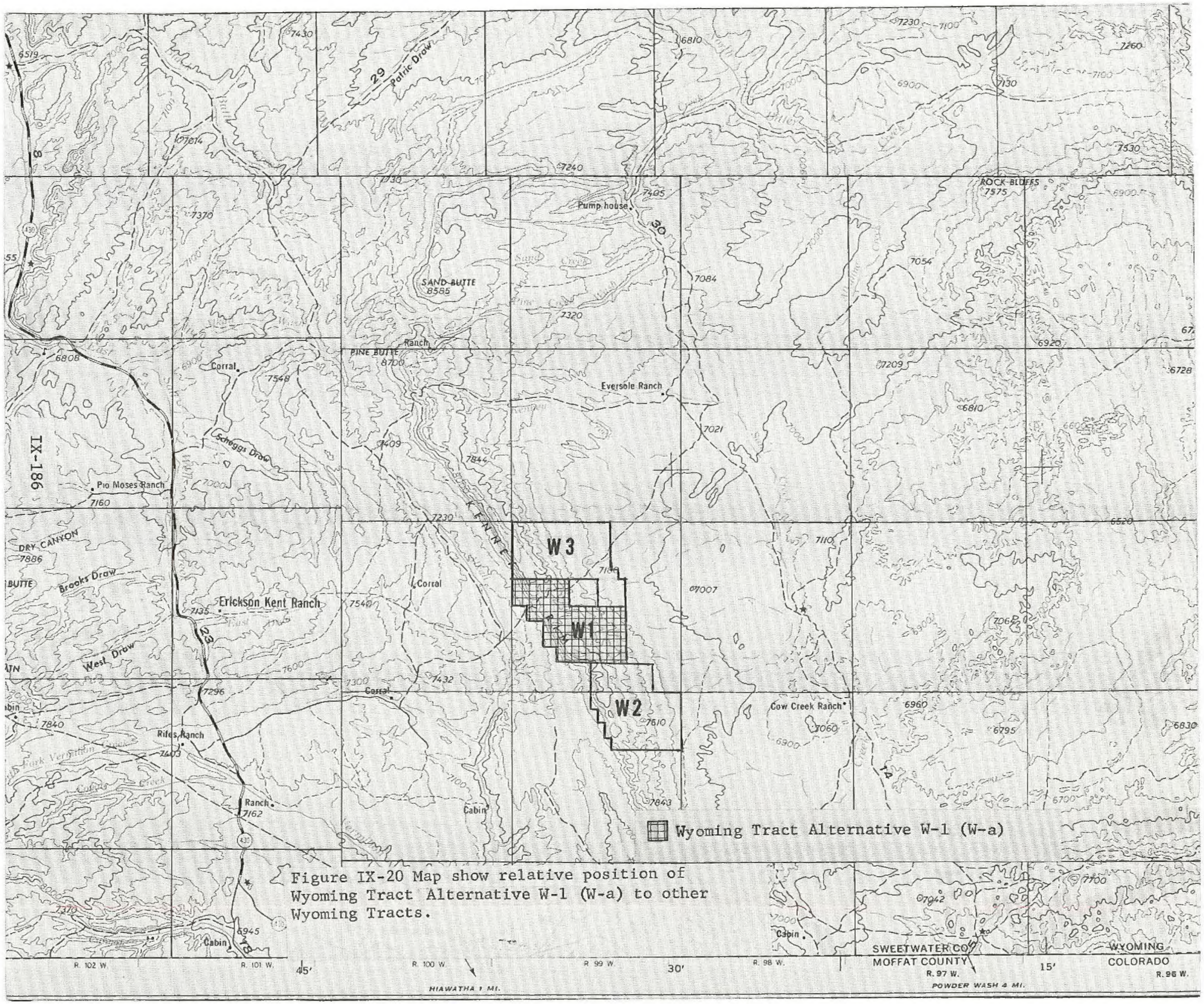

Figure IX-20 Map show relative position of Wyoming Tract Alternative W-1 (W-a) to other Wyoming Tracts.

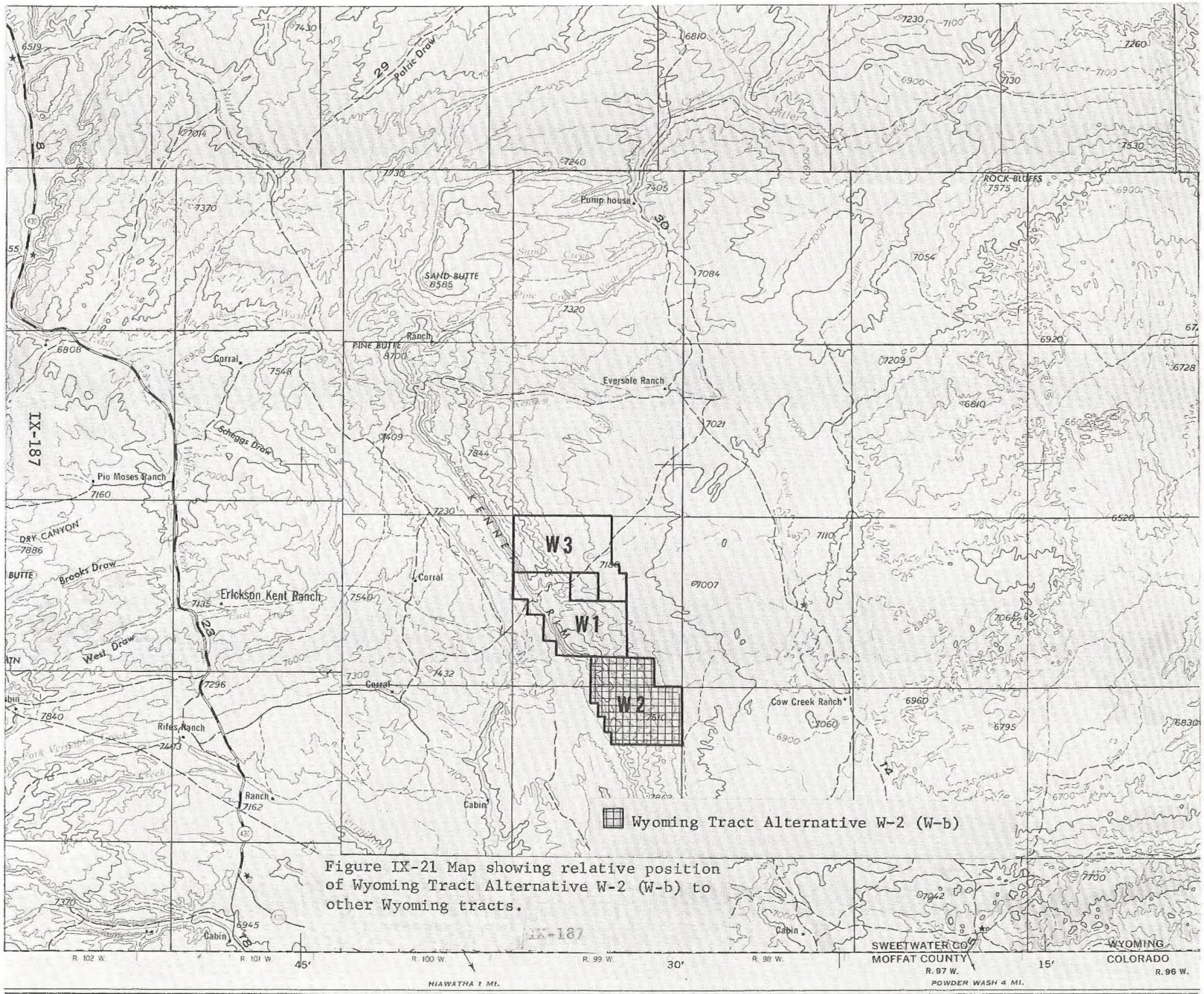

Figure IX-21 Map showing relative position of Wyoming Tract Alternative W-2 (W-b) to other Wyoming tracts.

IX-187

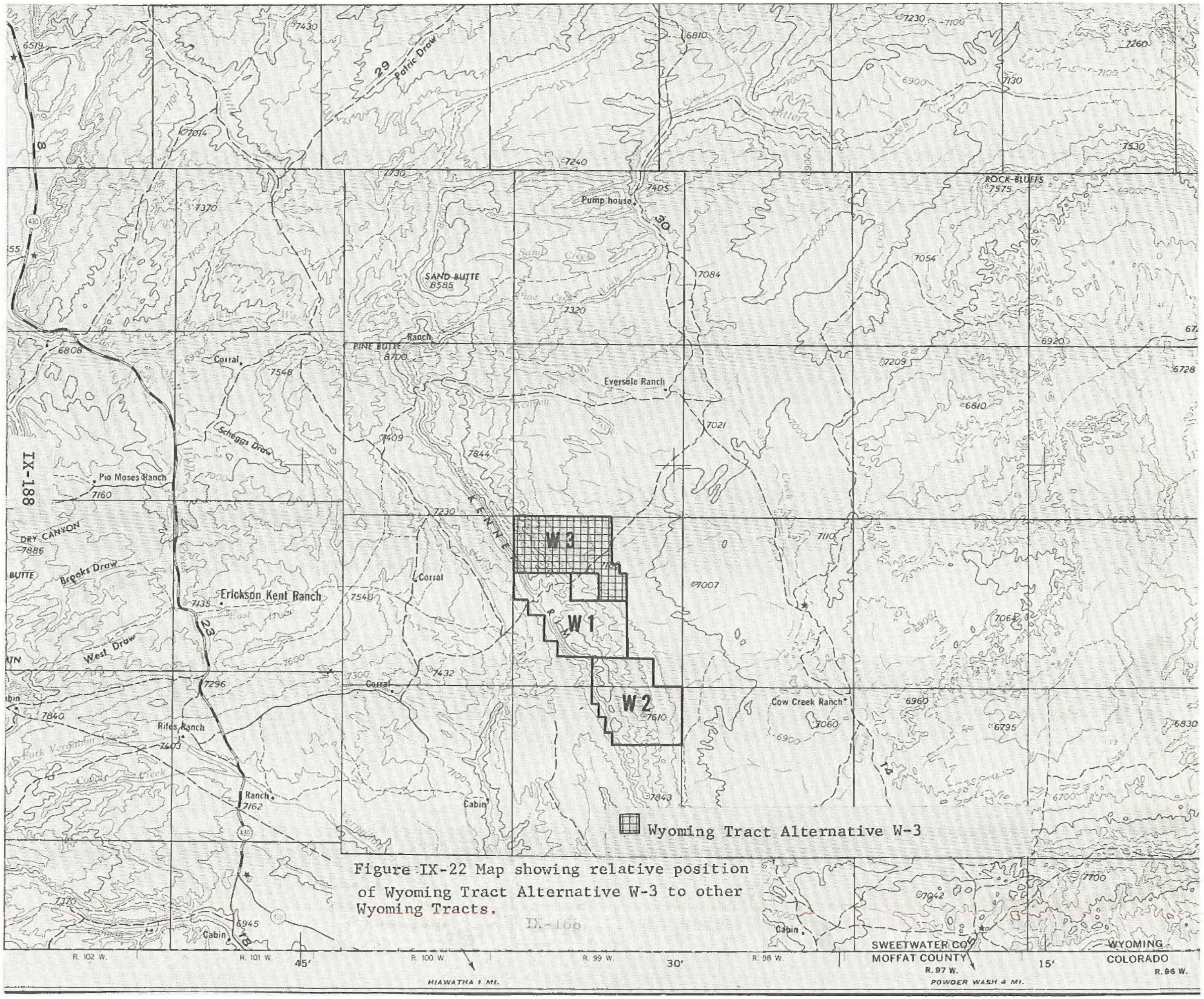

Figure IX-22 Map showing relative position of Wyoming Tract Alternative W-3 to other Wyoming Tracts.

Tract No. W-3

T. 14 N., R. 99 W., 6th P.M. Sweetwater County, Wyo.

Sections: 3 - Lots 3, 4, S½NW¼; SW¼
4 - All
5 - All
6 - All
7 - All
8 - All
9 - All
10 - W½; SW½SE½
15 - All

Total - 5,141.70 acres

Tract W-1: All public domain.

Tract W-2: All public domain

Tract W-3: All public domain except NW¼SE¼ Sec. 9, which is patented (1093975) without mineral reservation.

Tract W-1: Entire tract covered by post-1920 claims; NE¼ Sec. 19 is covered by a pre-1920 claim.

Tract W-2: E½, Sec. 33 is covered by post-1920 claims; there are no pre-1920 claims on the tract.

Tract W-3: All of Secs. 3, 10, and 15 are covered by one or more post-1920 claims; there are no pre-1920 claims on the tract.

Elevation.- The elevation of the ridge line at the crest of Kinney Rim near the weatern edge of Tracts W-1, W-2, and W-3 ranges from from approximately 8,000 feet to approximately 8,200 feet. The elevation of the lower eastern side of the three contiguous tracts. ranges from approximately 7,100 feet to approximately 7,300 feet. Elevation of the slope below the Kinney Rim at the west edge of the tracts is as low as 7,200 feet.

<u>Climate</u>.- The climate of all three tracts is semiarid with 10-12 inches average annual precipitation - 55°F to 107°F temperature range. Summer daily high temperatures generally range from the low 70's to the mid 80's. The mean winter temperature is about 20°F above zero.

<u>Access</u>.- A bladed unsurfaced road extending from State Highway 430 about 14 miles west of Tracts W-1, W-2, and W-3 to the Eversole Ranch about 8 miles northeast from the tracts passes through the northern portion of Tract W-1. This road is considered seasonal, as drifting snow precludes use at times during winter months.

Additional access is provided by an unsurfaced county road extending south from Interstate Highway 80 approximately 36 miles through Bitter Creek to the Eversole Ranch.

An unsurfaced road extends north from Powder Wash, in Moffat County, Colorado, and connects with the road between Bitter Creek and the Eversole Ranch.

<u>Vegetative Type</u>.- Desert shrub vegetative types are typical of the tracts; however, small portions of the tracts are covered by mountain shrub vegetative types.

<u>Geologic Features</u>.- The nearest assayed core hole (U.S.B.M. Washakie Basin Corehole 1, located in the SW¼ Sec. 17, T. 14 N., R. 99 W.) showed two sequences of oil shale in the Laney Shale Member, ranging between 40 to 50 feet in thickness that had an average yield of about 20 gallons per ton.[1/] In the core hole, these oil shale zones were in the interval between 346 and 542 feet. Collectively, these two sequences, totaling 90 feet, contain shales that may yield 600 million barrels of oil on each tract.

1/ Average approximately, but not less than 20 gallons/ton. Intervals greater than 10 feet thick and averaging less than 15 gallons/ton were not considered. This same criteria was used for all averaging of oil shale (gallon/ton) in this statement.

Structure.- Beds located on these tracts all strike northwest. Northeast dips increase in a northeast direction across the sites from about 9 to nearly 30 degrees. Two normal faults occur along the west margin of W-1 with a displacement of less than 100 feet. A normal fault about 1.5 miles long also occurs on the west margin of Tract W-3 with a displacement of less than 100 feet. No faults are known to exist on Tract W-2. Overburden is as follows:

Stratigraphic Unit	Overburden Maximum	Overburden Average	Overburden Minimum
Top of oil shale part of the Laney Member	2,400	600	0
Top of Cathedral Bluffs Tongue	2,900	1,100	0
Top of Wilkins Peak Member	4,900	2,200	900
Top of Tipton Shale Member	5,200	2,500	1,200
Top of Luman Tongue	5,600	2,900	1,600
Top of main body of Wasatch Formation	5,900	3,200	1,900

Hydrology.- The limited hydrologic data available for these tracts indicate the following:

(1) Water occurs above, below, and probably in the oil shale.

(2) Ten wells testing the Laney Shale have yielded amounts of water ranging from 0 to 200 gpm. Ground water is under artesian pressure in the vicinity of the oil shale.

(3) The water from a well in theLaney about a township north of the tracts contained 450 ppm dissolved solids.

Air and Water Quality Characteristics:

(1) Surface Water Quality.- The nearest recorded data was taken from Vermillion Creek near the confluence with Green River,

about 25 miles to the southwest. These data indicate high content of total dissolved solids (1231 to 1710 ppm), chloride (50-269 ppm), sulfate (5.3-276 ppm), and carbonate (131-392 ppm).

(2) Air Quality.- Ambient air is relatively free of contaminants. Prevailing winds are from the west-southwest. Velocities average approximately 12 miles per hour.

Transportation Network:

(1) Roads.- Existing roads are described under "Access." They can be improved without major relocation; however, development of the tracts for shale oil recovery would probably involve consideration of a new, more efficient road system.

(2) Pipelines.- No oil pipelines are located on or near the tracts. A 20 inch gas pipeline that connects with other gas lines near Rock Springs is located approximately 10 miles south of the tracts.

Power Sources.- A major source, the Jim Bridger plant, is under construction approximately 40 miles north of the tracts. This plant is scheduled for completion September 1976, and will have three 500-megawatt units. A second possible power source is the Hayden Plant located some 90 miles southeast in Colorado.

Land Use.- Present land use consists of livestock grazing, wildlife habitat, and recreation.

Vegetation and Soils.- The majority of the soils in the area fall within the friable, grayish-brown loams. These soils are typically brownish gray in color and generally are underlain by free lime at a depth of 5-12 inches. The depth of the weathered layer varies from 6-50 inches but is generally quite shallow.

Plant Species:

(1) <u>Browse</u>

Artemisia nova	Blacksage
Atriplex nuttalli	Gardner's saltbush
Artemisia tridentata	Big sage
Sarcobatus vermiculatus	Greasewood
Cercocarpus montanus	Mountain mahogany
Chrysothamnus spp.	Rabbitbrush

(2) <u>Grasses</u>

Sitanion hystrix	Squirreltail
Agropyron smithii	Western wheatgrass
Poa secunda	Sanberg's bluegrass
Carex spp.	Sedges
Oryzopsis hymenoides	Indian ricegrass
Agropyron dasystanbyum	Thick spike wheatgrass

(3) <u>Trees</u>

Juniperus osteosperma	Juniper

<u>Vegetation Conditions</u>.- The east-sloping portions of the tracts have a fair vegetative cover and little or no accelerated erosion occurs.

The west slopes have a sparse vegetative cover and are in a severe erosion classification. The steeper slopes have no topsoil and very sparse vegetation; consequently, most precipitation runs off carrying soil particles to the lower, flatter slopes.

Revegetation of waste piles and disturbed areas will be difficult because of the limited topsoil and limited amount of precipitation.

<u>Wildlife</u>.- A variety of wildlife species are supported by the desert-shrub and mountain-shrub vegetative types found on these tracts. Species using the tracts include antelope, mule deer, sage grouse, cottontail rabbit, coyote, bobcat, dove, eagle, elk, blue grouse, ruffed grouse, chukar partridge, mountain lion and numerous other small birds and mammal species.

Wild horses frequent the area through the year.

The tracts are situated in a winter-range area for antelope, mule deer, and sage grouse. Wild horses make use of the general area during the winter months.

Livestock Grazing.- Sheep graze the area during late fall, winter, and early spring. Cattle and domestic horses also graze the area during summer and fall. Grazing capacity of the three tracts is estimated to be approximately 1,900 AUM's.

One livestock operator is presently licensed to graze in this area.

Improvements.- One reservoir and several springs are located on the tracts. These are critical livestock water sources.

Archeology.- Structures and/or related forms of antiquity are unknown on the tracts. However, Indian cultures are known to exist from the unearthing of fire-pot areas near the tracts. Folsom and Yuma cultures have been unearthed in the area.

Fossils are abundant in the general area. Turritella agate is found in quantity on the Laney Rim on the north side of Washakie Basin. Fossil mammal remains are found in formations overlying, underlying, and intertwining with the Green River Formation.

Recreation and Aesthetics.- Present recreational use of the tracts includes hunting, rock collecting and sightseeing.

Environmental Impact of W-1 Development

This tract appears best suited to development by in situ methods. It is designated Tract W-a in the proposed prototype leasing program and the anticipated impact is described in Sections A through G in Chapter IV of this volume.

The only additional notation would be:

Two sequences of oil shale bedding, each 47 feet thick, occur on tract and appear to have an average yield of about 20 gallon/ton. Estimated resources which would be affected approximate 600 million bbls. for the entire tract.

Environmental Impact of W-2 Development

This tract appears best suited for development by in situ methods. It is designated as W-b in the proposed prototype leasing program and the anticipated empact is described in Sections A through G in Chapter IV of this volume.

The only additional notation would be:

The impact would be expected to be confined to oil shale resources. No associated minerals are indicated. Oil shales resources that would be affected approximate the same level for all three tracts, about 600 million barrels for the tract.

Environmental Impact of W-3 Development

As is the case for Tracts W-1 and W-2, this tract appears best suited to development by the in situ extraction method. Such development would probably have the following environmental impacts:

Water.- The effect on water supply and water quality would be similar to that described for Tract W-a. One small reservoir and 7 springs could be affected in the southern and eastern areas of the tract.

Land.- The impact on land from surface disturbance and topographic change would also be similar to that described for Tract W-a.

Grazing.- Approximately 1,900 AUM's forage are used annually by sheep and cattle over the 3 tracts. One operator is involved. Sheep graze during late fall, winter and early spring. Cattle use the area with domestic horses during summer and early fall. These operations would be affected.

Recreation.- Hunting, hiking, and rock hounding occur on the area but use is light. The impact on recreation would be in the form of some slight reduction of these activities in the area.

Cultural Features.- A road from Bitter Creek, about 25 miles northeast of the tract, through the Gap on Kinney Rim transects this tract and Tract W-1. Improvement would be likely and increased traffic through the area expected. The stock pond on the tract would likely be dried up and its use abandoned.

Minerals.- The impact would be about the same as that described for Tract W-a. The oil shale resources that would be affected, as for the other two tracts, are estimated to be approximately 600 million barrels for the tract.

Archeological and Historical.- The impact on these resources would be the same as that described for Tract W-a.

Socioeconomic.- The impact would be similar to that described for Tract W-a. Rock Springs would be the principal community affected and the public road (Route 430) from Rock Springs through this area west of Kinney Rim, as well as the ranches along the way, would be in the zone of influence.

Air.- The impact on air quality would be similar to that described for Tract W-a except that southwesterly winds could carry the plume close to the Eversole Ranch.

Wildlife.- The impact would be similar to that described for Tracts W-a and W-b.

Vegetation.- The impact would be about the same as that described for Tract W-a.

H. Tract Selection Procedure

The preceding section described each tract nominated for development under the proposed program and the possible environmental impacts of development of alternative tracts to the tracts selected. The present section details the procedure used in evaluating the moninated tracts. While this section is not believed to be needed for this environmental statement, it is being presented due to the interest expressed during public review of the September 1972 draft of this Final Environmental Statement.

1. General Considerations

The evaluation of alternative tracts has been guided by the four objectives of the proposed prototype leasing program detailed in Chapter I of this volume. The first 2 of these, listed below, provide the basic rationale out of which the tract selection criteria were developed and applied. These are:

(1) Stimulating development of commercial oil shale production and technology by private industry.

(2) Insuring the environmental integrity of the affected areas, and concurrently defining, describing, and developing a full range of environmental safeguards and restoration techniques that can be incorporated into the planning of a mature oil shale industry.

Achievement of the third of the four objectives, which is to permit an equitable return to all parties in the development of this public resource, is to be attained through the lease, as presented in Chapter V of this volume. The

fourth objective bears directly on the selection process, that is, to develop management expertise in the leasing and supervision of oil shale development in order to provide the basis for future administrative actions, and is considered below in this section.

The means proposed to achieve the program objectives is to offer tracts of public oil shale lands that will most likely be developed in the pattern described in Section A of this chapter. Since the purpose of the prototype program is not only to stimulate the development of processing methods, but also to develop techniques of waste management and procedures to minimize environmental impacts, tracts should be selected which present the typical difficulties to be encountered. The resulting advances in pollution control applications and environmental protection would then indicate whether large-scale development would be acceptable in terms of its environmental impact. The location and nature of the oil shale resources must therefore be considered.

As documented in Volume I, Chapter II and in studies prepared for the Department by the involved state governments (8, 9, 10), the oil shale region encompasses four distinct geological provinces - the Piceance Creek Basin of Colorado, Uinta Basin of Utah, and the Washakie and Green River Basins of Wyoming. These geologic basins have variant environments

and patterns of land use. In addition, the characteristics of the resource itself (richness, thickness, depth of overburden, associated minerals, and water quality and quantity) vary widely in the region. In general, variations in resource characteristics between geologic basins are much greater than variations within a specific basin.

Of the four basins, nearly all of the research conducted by both industry and government has been directed toward mining and surface processing the oil shales of Colorado's Piceance Creek Basin due to the nature of the deposits which are thicker and higher in quality than the other three basins (See Volume I, Chapter II, Section A.12). Over 100 years of worldwide effort has been directed toward mining and surface processing of oil shale, over 30 years of which have been directed toward the development of modern means of processing the higher grade oil shale deposits in this country. By comparison, in situ technology has been under active development for about a decade. The highest grade resources contain some 600 billion barrels of oil in sections at least 10 feet in thickness and averaging 25 or more gallons per ton. However, the majority of the oil shale resource (1.2 trillion barrels of the 1.8 trillion barrels in place) in the 3 states is low in quality[1/] and is not generally

1/ In sequences more than 10 feet thick having an average yield of 15 to 20 gallons per ton.

amenable to development by the mining and surface processing systems developed to date.

Development Possibilities

Two criteria were selected to gauge the range of development possibilities and the degree of industry interest: studies by the involved states in 1970, and informational core drilling and lease nomination in 1972, both of which are considered separately below.

(1) State Studies.- As documented in Chapter I, Section B of this volume, the Department of the Interior, in May 1970, requested the Governors of Colorado, Utah, and Wyoming to form panels to study the environmental impact of underground mining, surface mining, and/or in situ operations at model sites they selected as typical of those that might be nominated for development by private industry. Of the three methods of development, only the application of surface mining may be constrained by suitable locations, for nearly every location represents a potential for in situ or underground development. To be economically viable to surface mine development, a specific site should have good quality oil shales, an over-burden to oil shale ratio that approaches 1:1, and a total overburden thickness no greater than several hundred feet. Such locations were found in each of the three oil shale states.

For example the State of Colorado identified one model surface mine location "...typical of several potential locations for surface mines in the area ..." (8, pg 51). Subsequent work by the U.S. Geological Survey (7) included this model location within a 75 - square - mile area amenable to such development; that is, less than 400 feet of overburden and containing some 8 billion barrels of oil in place. Part of the area - about 25 square miles - is overlain by less than 200 feet of overburden and contains in place resources of about 2.5 billion barrels.

The State of Utah also identified a large (95 square - mile) area in that state amenable to surface development (9, pg 35). In that area, 25 gallon per ton oil shale ranges in thickness from 25 to 75 feet and the overburden from 0 to 250 feet. Some 4 billion barrels of oil is estimated to be in place.

Two model locations for surface mines were also identified by the State of Wyoming, one along the Kinney Rim (10, pg 20) and the other near the Green River (10, pg 26).

The studies conducted by the state Governments at the request of the Department also identified model locations for underground and in situ developments. These studies formed the basis for the Department's June, 1971 preliminary Draft Environmental Statement (14) and served to illustrate

that a full range of development options may be expected as an oil shale industry grows to maturity across the region. Underground mining and surface processing is expected to constitute a principle method of development, but some 160 square miles in Colorado and Utah have been identified as potential areas for surface mine development. In situ processing could be applicable to the majority of the resource which is contained in the lower quality oil shales. Thus, it was shown that the three basins offered areas suitable to various means of development.

(2) Information Core Drilling/Tract Nomination.- At the time of the initial announcement of the proposed prototype leasing program, in June 1971 (15), specific sites had not been nominated for development by private industry. Informational core drilling was authorized to access the environmental and resource characteristics at specific sites. All information acquired by the participants in the drilling is also provided to the Department for its use as well. Expenditures by private industry for core drilling (no public monies were involved other than supervision of the drilling) and lease nominations, which were also authorized, further served to identify the areas of greatest commercial interest. From June 1971 through November 1971, a total of 16 core holes had been drilled, 13 in the Piceance Creek Basin and 3 in the Uinta Basin.

The next step in the process of identifying the prototype oil shale tracts was a call for nominations of areas for oil shale leasing, which was published in the Federal Register on November 2, 1971. The notice also requested that nominations be accompanied by data on environmental aspects of the development of the lands proposed for leasing. This procedure was followed to determine what oil shale areas appeared to be of potential economic interest and the types of development envisioned. It also was expected to give an indication of the overall level of interest in leasing and development of the Federal oil shale resources.

At the close of the nomination period 15 companies had submitted 23 nominations on a total of 18 separate tracts. The industry nominations covered 13 tracts in the Piceance Creek Basin of Colorado, 4 in the Uinta Basin of Utah, and 1 in the Washakie Basin of Wyoming. Two additional tracts adjoining the industry nominated tract were nominated by the State of Wyoming, bringing the total of nominated tracts to 20. These tracts have been identified in Section G of this chapter in Figures IX-3, IX-16, and IX-20.

Tract nominations by industry were considered a direct indication of interest in particular areas. Of twenty-five nominations submitted to the Department of the Interior, five in Colorado were superimposed or very nearly so and two nominations in Utah covered essentially the same area.

Proximity of one tract to another was also considered indicative of interest in a particular area. The duplicate nominations may be identified in this chapter as those tracts with multiple tract number designations.

The distribution of nominated tracts gives further indication of areas of industry interest. As can be seen from Figure IX- 3 the plotted nominations in Colorado are fairly well distributed across the Piceance Creek Basin with concentrations in the north-central, west-central and south-central portions. However, considering the multiple nominations plus one adjoining tract nomination, there is a concentration of six nominations in the west-central part of the basin (Nominations C-4 (5, 7, 8, 17[1/] and C-10).

In Utah three of the four nominated tracts are in the central part of the Uinta Basin (Tracts U-1, U-2, and U-4 (5)[1/] on Figure IX-16).

The single industry nominated tract in Wyoming is located in the Washakie Basin. It was followed up by the two Wyoming State nominations (See Figure IX-20) of tracts adjoining it on the north and on the south. No tracts were nominated in the Green River Basin of Wyoming and it was construed that the

1/ Indicates duplicate nominations for the same tract.

Washakie Basin was the only one in Wyoming with current industry interest.

Core drilling completed prior to submission of tract nominations was distributed in Colorado as follows: five holes on or in the vicinity of Tracts C-4 (5, 7, 8, 17); five holes in and south and east of Tract C-13; one hole on Tract C-6; one hole on Tract C-10; and one hole on Tract C-12. Additional holes were authorized on C-12 but were not drilled.

All three holes drilled in Utah were located on the duplicate nomination Tracts U-4 (5).

The numbers of participants in the various core drilling programs also reflect similar concentrations of interest. In Colorado nine companies participated in the five hole core drilling program in the area of Tract C-4 (5, 7, 8, 17); seven companies drilled one hole on Tract C-6; eight companies drilled five holes in the vicinity of Tract C-13; one company drilled one hole on Tract C-10; and one company drilled one hole adjacent to Tract C-12. In Utah four companies participated in the three holes drilled on Tracts U-4 (5).

2. Alternative Sizes and Numbers of Tracts

The proposed program contemplates leasing of 6 tracts of not more than 5,120 acres each. It would be possible to lease tracts comprising less than this amount. This option was considered in light of the commercial levels of production anticipated as the result of the proposed prototype program

which is predicated upon the investment of large amounts of private risk capital. If private industry does not choose to invest in the development of the selected tract, the program cannot succeed. Therefore, it is essential that the sites selected be those most likely to attract private investment, i.e., the contained resource must be of such quantity and quality that a prospective bidder will feel justified in the investment of substantial amounts of money with the reasonable prospect of developing a profitable operation. With investments expected to range from about $230 million for a commercial in situ operation of 50,000 barrels per day to $440 million for a commercial surface mine development at 100,000 barrels per day (See Analysis, Volume I, Chapter III, Table III-20 to III-25), a sufficient amount of resource must be offered to allow at least a 20-year period to amortize the investment. By law (16), a person, association, or corporation may take and hold directly only one oil shale lease, which shall not exceed 5,120 acres. While total recoverable resources will vary from tract to tract (See Table I-1, Chapter I) and according to development method, in general it is considered unlikely that a tract of significantly less than 5,120 acres would contain resources of sufficient quantity and quality to permit an economically viable investment.

Development of smaller tracts would cause less overall impact than those described in Volume IV for a given location

if the total recoverable resource is less than that required to support commercial operations. To support a demonstration plant of 10,000-ton-per-day capacity, as described in Section C of this chapter, would require about 500 acres or less if the useful life of the demonstration is 10 years. The adverse environmental impacts associated with a change in lease size would therefore depend on the scale of operations that could be supported. At one extreme is the commercial scale impacts described in Chapter IV, at the other is the impacts associated with a demonstration plant similar to that discussed in Section C of this chapter.

Considering one of the objectives of the proposed program to stimulate development of commercial level production and technology, it is necessary to provide a sufficient amount of resource to encourage pioneering development and flexibility in the manner of resource development. The proposed program therefore provides for leasing approximately the full acreage permitted under existing law.

It would also be possible to lease fewer tracts than the six tracts proposed for the prototype program. A minimum of four tracts would be sufficient to test development by surface mine, underground mine in an area with large amounts of ground water, underground mine in a low ground-water content area, and in situ processing in the oil shale basins in which a mature industry would likely develop. However, the quantity

and quality of the resource in the Uinta Basin of Utah and Washakie Basin of Wyoming is believed to be insufficient to stimulate development of commercial production on a one-tract basis. A minimum of two tracts in these two basins is needed to provide sufficient resources to support development on a commercial scale over a period of time long enough to amortize the investment.

Adverse environmental effects on one tract in the Washakie and Uinta Basins would generally be similar to those described in Chapter IV for the Utah and Wyoming tracts, but would necessarily be on a smaller scale due to the limited resource, much like those associated with a demonstration plant, as discussed in Section C of this chapter. Adverse effects in the Piceance Creek Basin would be similar to those described in Chapter IV for Tracts C-a and C-b.

The prototype tracts selected for this program offer the potential for alternative means of commercial oil shale development. The most likely pattern of development was given in Section A of this chapter. However, Tract C-a, judged most likely for development by surface mining methods, is also suitable for development by underground or in situ methods. Tract C-b, which would likely be an underground mine in an area that will require mine dewatering prior to and during development, is also amenable to in situ development. Tracts U-a and U-b, most likely as underground mines in an area where

substantial amounts of water are not expected, could also be developed by in situ methods. Tracts W-a and W-b are believed to be amenable only to in situ processing.

In combination, the six tracts selected from this proposed prototype program provide the opportunity to utilize alternative technical approaches among three of the basins, the Piceance Creek Basin of Colorado, the Uinta Basin of Utah, and the Washakie Basin of Wyoming. Being geographically dissimilar and located in different states, each with its own direct interest in the progress of resource development, these tracts provide a balanced opportunity to develop a broad range of management expertise in supervising oil shale extraction as well as a representative sampling of the range of conditions to be encountered against which the efficacy of environmental protection and rehabilitation techniques can be measured. While tracts in the Green River Basin may logically be included in a prototype program, no nominations were received for tracts in this basin. Additionally, the Bureau of Mines is, and has been since 1969, conducting research on in situ processing technology in this basin. Due to the lack of interest as indicated in the nominations and existence of an active program of research there already, the exclusion of prototype tracts in the Green River Basin is not considered a serious detriment toward achieving the stated objectives of the prototype program.

Considering the above factors, it was concluded that program objectives could best be met by offering two tracts in Piceance Creek Basin, two tracts in Uinta Basin and two tracts in Washakie Basin which together represent a balanced opportunity to evaluate adequately a wide range of technology options and impacts.

3. Evaluation of Alternative Tracts

The call for nominations on November 12, 1971, by the Department of the Interior resulted in 25 nominations as discussed in Section H. 1.a.(2) above. After elimination of duplicate nominations, 20 individual nominated tracts remained. These nominations were sufficient to achieve the program objectives and allow consideration of the full range of resource development and environmental conditions and alternatives. Therefore, additional tracts were considered unnecessary.

All lease tract nominations were sent to the Oil Shale Field Task Force with company identifications deleted. An interagency, intergovernmental, and interdisciplinary committee was designated to evaluate the nominations with other available data and to recommend tracts for the prototype leasing program.

The relevant resource parameters and the expected environmental impacts caused by development at a particular tract have been detailed in Section G of this chapter. In selecting the tracts to be proposed for leasing from those nominated, a screening process was employed using the following

interrelated factors to measure the capability of the tracts to meet the program objectives: areas of industry interest and degree of interest, comparative resource values, potential for stimulation of commercial level production, suitability for development by various technological methods, potential for resource recovery, sufficiency and reliability of resource data, potential inhibiting constraints (e.g., the amount and quality of ground water), and comparative environmental effects, including off-tract effects.

The screening was accomplished by a two-step procedure. The first step was a comparative analysis involving application of the first seven of the factors listed above, which may be grouped under the general category of resource development potential. The second step involved a comparative analysis of the potential environmental impacts of development on water quality, air quality, vegetation, fish and wildlife, recreation, grazing, land and cultural features, archeological and historical areas, and socioeconomic conditions for those tracts which qualified under the first step. These analyses are given in the sections immediately below.

a. Resource Development Potential

The date used for this analysis were presented in Section G of this chapter and are summarized for each of the nominated tracts in Table IX- 4. Also contained in the table is the

TABLE IX-4 .--Resources and Development Potential; Colorado

Tract	Resource Values			Geologic Features			Development Potential			
	Oil Shale, Feet 2/		Associated Minerals	Overburden, ft.	Structure		Surface	Underground	In Situ	Summary
	Mahogany	Lower			Dip	Faults				
C-1	60	440	Several hundred feet of nahcolite and dawsonite bearing shale. Some halite.	1100	NE at 200 ft/mi.	None apparent	Not desirable; waste to ore ratio is 4.2 to 1.1/	Limited potential since less reserves in Mahogany zone than similar tracts.	Limited potential; contains only 2 thin zones of 30 GPT above leached zone.	Other tracts more attractive because of greater reserves in Mahogany zone.
C-2	Less than 15	Less than 100	Probably bedded nahcolite in southern 1/3 of tract and pods in remainder. Dawsonite in several hundred feet of section.	700	SE at 150 to 600 ft/mi.	NW trending fault of small displacement.	Feasible but not favorable; waste to ore ratio is 63.0 to 1.1/	Possible but average grade of oil shale is low.	Favorable if resource recovery is satisfactory.	Other tracts offer greater potential.
C-3	Less than 15 on west edge to more than 50 on east edge.	Less than 100 on west edge. Increases in thickness and value on east edge.	Probably bedded nahcolite in the eastern part. Several hundred feet of dawsonite.	500	E and NE at 300 to 500 ft/mi.	None apparent	Some potential because of moderate depth of overburden; waste to ore ratio is 10.0 to 1.1/	Feasible but other tracts contain greater mining thickness	Favorable because of moderate overburden and thickness of 30-40 GPT is sufficient.	Other tracts offer greater potential
C-4, 5, 7, 8 and 17 (C-a)	50	400	Nahcolite probably present in pods. About 500 feet of section contains dawsonite.	450	E at 300 to 400 ft/mi.	NW trending graben bisects the area. Maximum displacement 175 feet	Practical because overburden; waste to ore ratio is 1.7:1.	Feasible	Feasible	Meets objectives of program.
C-6	100	500	Several hundred feet contains nahcolite, some bedded. 700-800 feet contains dawsonite. Thick beds of halite occupy much of 300 feet interval underlying leached zone.	1100	N at 50 ft/mi. in northern part. NNW at 100 ft/mi in southern part.	None apparent	Not desirable; waste to ore ratio is 3.2 to 1.1/	Good	Satisfactory	Could meet objectives of program.

1/ Waste is all material that would be removed during surface development (overburden plus lower grade oil shale mined but not processed). Waste to ore ratio represents a comparison of the waste material to the oil shale that averages approximately, but not less than, 30 gallons per ton and is at least 10 feet in thickness. Intervals greater than 10 feet thick and averaging less than 15 gallons per ton were not considered in calculating the oil shale zone.

2/ Thickness of oil shale refers to 30 gal/ton oil shale as defined in footnote 1/.

TABLE IX-4 .--Resources and Development Potential; Colorado (continued)

Tract	Resource Values			Geologic Features			Development Potential			
	Oil Shale, Feet 2/		Associated Minerals	Overburden, ft.	Structure		Surface	Underground	In Situ	Summary
	Mahogany	Lower			Dip	Faults				
C-9	100-130	Probably none thicker than 10	Essentially no nahcolite. Probably less than 100 feet of section contains dawsonite.	1000	N at 100 ft/mi.	None apparent	Uneconomical; waste to ore ratio is 7.0 to 1.1/	Good for mining Mahogany zone and R-6* bed.	Feasible	Does not meet objectives of program; absence of lower shale beds preclude development of needed technology.
C-10	70	700	Nahcolite has all been leached, about 600 feet of section contains dawsonite.	900	NE at 100 to 150 ft/mi.	Probably a few of slight displacement in SW part of tract.	Feasible but less potential because of overburden depth; waste to ore ratio is 1.6 to 1.1/	Favorable, but water may be a problem.	Favorable	Could meet objectives of program.
C-11	150	750	Bedded nahcolite in about 500 feet of section. Dawsonite in more than 700 feet of section. Thick beds of halite in 300 feet underlying leached zone.	1100	W at 150 ft/mi. in east part. NE at 150 ft/mi. in west part.	NW trending graben in SE¼. Probably small displacement	Same as C-10; waste to ore ratio is 1.9 to 1.1/	Excellent because of thickness of minable beds.	Possible	Meets objectives of program.
C-12	Less than 15	Less than 15	Probably very little nahcolite but probably several hundred feet contains dawsonite.	300	SW at 200 to 400 ft/mi.	None apparent	Limited potential because of limited total resources	Fair	Feasible	Does not meet objectives of program.
								*See Figure II-35, Chapter II, Volume I.		

1/ Waste is all material that would be removed during surface development (overburden plus lower grade oil shale mined but not processed). Waste to ore ratio represents a comparison of the waste material to the oil shale that averages approximately, but not less than, 30 gallons per ton and is at least 10 feet in thickness. Intervals greater than 10 feet thick and averaging less than 15 gallons per ton were not considered in calculating the oil shale zone.
2/ Thickness of oil shale refers to 30 gal./ton oil shale as defined in footnote 1/.

TABLE IX-4 .--Resources and Development; Colorado (continued)

Tract	Resource Values			Geologic Features			Development Potential			
	Oil Shale, Feet 2/		Associated Minerals	Overburden, ft.	Structure		Surface	Underground	In Situ	Summary
	Mahogany	Lower			Dip	Faults				
C-13 (C-b)	More than 100	About 300	Bedded nahcolite in NW part. Beds of nahcolite through several hundred feet. About 300 ft contains dawsonite.	1100	N at 150 ft/mi in most of area. SW at 200 ft/mi along north boundary.	None apparent	Uneconomical; waste to ore ratio is 5.9 to 1.1/	Outstanding because of minable beds of high grade shale.	Feasible	Meets objectives of program because of potential for development of technology for mining deep shales.
C-14	100-130	None	Amount of nahcolite probably insignificant. Probably less than 100 ft contains dawsonite.	900	N at 200 ft/mi.	None apparent	Uneconomical; waste to ore ratio is 6.9 to 1.1/	Same as C-9	Feasible	Does not meet objectives of program. See C-9.
C-15	100-130	None	Same as C-14	1000	N at 200 ft/mi	None apparent	Uneconomical; waste to ore ratio is 7.6 to 1.1/	Same as C-9	Feasible	Does not meet objectives of program. See C-9.
C-16	About 90	From 300 in south to 750 in north.	Nahcolite present throughout tract. Zone thicker in the northern part. About 500 feet of dawsonite in south and 600 feet in north.	1100	SE at 150 ft/mi.	None apparent	Little potential; waste to ore ratio is 2.5 to 1.1/	Favorable because of minable thickness of oil shale beds.	Good Potential	Could meet objectives of program.

1/ Waste is all material that would be removed during surface development (overburden plus lower grade oil shale mined but not processed). Waste to ore ratio represents a comparison of the waste material to the oil shale that averages approximately, but not less than, 30 gallons per ton and is at least 10 feet in thickness. Intervals greater than 10 feet thick and averaging less than 15 gallons per ton were not considered in calculating the oil shale zone.
2/ Thickness of oil shale refers to 30 gal./ton oil shale as defined in foot note 1/.

TABLE IX-4 .--Resources and Development Potential, Utah

Tract	Resource Values			Geologic Features			Development Potential			
	Oil Shale, Feet 2/		Associated Minerals	Overburden, ft	Structure		Surface	Underground	In Situ	Summary
	Mahogany	Lower			Dip	Faults				
U-1	About 40	--	Several gilsonite veins; one has a maximum width of 30 in.	850	N to NW at 2°	None apparent	Not desirable; waste to ore ratio is 21.2 to 1.1/	Feasible	Feasible	Less potential for meeting objectives than other tracts.
U-2 (U-a)	About 45	--	None apparent	850	NW at 2°	None apparent	Not desirable; waste to ore ratio is 18.9 to 1.1/	Favorable because of depth, thickness, and grade of minable beds.	Favorable	Meets objective of program.
U-3	About 25	--	Several gilsonite veins; one has a maximum width of 36 in.	2300	NW at 1° to 2°	None apparent	Not suitable; waste to ore ratio is 92 to 1.1/	Feasible but unlikely because of thickness and grade of minable beds	Feasible	Could meet objectives of program for in situ recovery technology
U-4, 5 (U-b)	About 50	--	One gilsonite vein less than 2 in. thick in west-central part.	700	W to NW at 2° to 4°	None apparent	Not desirable; waste to ore ratio is 18 to 1.1/	Same as U-2	Favorable	Meets objectives of program

1/ Waste is all material that would be removed during surface development (overburden plus lower grade oil shale mined but not processed). Waste to ore ratio represents a comparison of the waste material to the oil shale that averages approximately, but not less than, 30 gallons per ton and is at least 10 feet in thickness. Intervals greater than 10 feet thick and averaging less than 15 gallons per ton were not considered in calculating the oil shale zone.
2/ Thickness of oil shale refers to 30 gal./ton oil shale as defined in footnote 1/.

TABLE IX- 4 .--Resources and Development Potential; Wyoming

Tract	Resource Values: Oil Shale, Feet 1/		Resource Values: Associated Minerals	Geologic Features: Overburden, ft.	Geologic Features: Structure		Development Potential: Surface	Development Potential: Underground	Development Potential: In Situ	Development Potential: Summary
	Mahogany	Lower			Dip	Faults				
W-1 (W-a)	Totals 90 in two zones approximately equal in thickness.	--	None apparent	600	NE at 9° to 30°, dips increase to NE.	2 normal faults along W margin, displacement less than 100 feet.	Not desirable because of high over- burden: ore ratio	Favorable, but low grade of shale may be uneconomical.	Favorable	Best potential for meeting ob- jectives of pro- gram.
W-2 (W-b)	Same as W-1	--	None apparent	600	Same as W-1.	None known	Same as W-1.	Same as W-1.	Favorable	Meets objectives of program.
W-3	Same as W-1	--	None apparent	600	Same as W-1.	A normal fault 1.5 mi long on W margin. Displacement less than 100 feet.	Same as W-1.	Same as W-1.	Favorable	Could meet objec- tives of program; slightly less potential than other tracts.

1/ Oil shale thickness refers to oil shale average approximately, but not less than 20 gallons/ton. Intervals greater than 10 feet thick and averaging less than 15 gallons/ton were not considered.

summary assessment of the potential for development by various means.

(1) Colorado.- Application of the resource development factors to the thirteen tract nominations in Colorado resulted in a ranking according to three broad categories: (a) resource poor, (b) rich oil shale in the Mahogany Zone with no rich lower oil shale zones and no associated minerals, and (c) rich shale oil resources in both the Mahogany Zone and lower zones, associated minerals, and a leached zone containing saline water. One of the tracts in this category was the subject of a high degree of industry interest. The screening then proceeded as follows:

<u>Category a</u> - Based on the available resource information, Tracts C-2, C-3, and C-12 contain insufficient shale oil resource to initiate and sustain commercial oil shale development, since the shale thickness in the Mahogany Zone is less than 15 feet throughout the tract and the thickness in the lower zone is less than 100 feet in most of the tract. The remaining tracts were then examined under Category 2.

<u>Category b</u> - Tracts C-9, C-14, and C-15 are underlain by thick (100-130 feet), rich, oil shales in the Mahogany Zone with sufficient to sustain a commercial size oil shale operation. However, the zones underlying the Mahogany Zone are not well developed (30 gallon per ton oil shale less than 25 feet thick) and do not contain significant amounts

of potentially valuable associated minerals (no nahcolite and less than 100 feet of dawsonite). Leasing of these tracts will not stimulate development of mining and processing techniques in the lower shale oil and mineral rich zones that underlie the heart of the basin.

The following tracts were given further consideration: C-1, C-4 (5, 7, 8, 17), C-6, C-10, C-11, C-13, and C-16.

Category c - Tracts C-1, C-6, C-10, C-11, and C-16 contain not only numerous thick (60 to 150 feet in the Mahogany Zone and 200 to 750 feet in the lower zones) rich zones of oil shale, but thick zones (several hundred feet on each tract) containing significant amounts of dawsonite and bedded nahcolite. Tract C-11 contains the greatest total resource potential of any tract nominated in the three-state area. In addition, all of Tract C-11 and parts of Tracts C-1, C-6, and C-10, and possibly the northern part of Tract C-16, are underlain by thick beds of halite interbedded with rich oil shale and nahcolite. The leached zone may reach up to the lower part of the Mahogany Zone, vary in thickness from 200 feet to as much as 1,000 feet and contain highly saline water.

Tract C-4 (5, 7, 8, 17)[1/] and Tract C-13 contain a thick (50 to more than 100 feet) rich oil shale sequence in

1/ Tract C-4 (5, 7, 8, 17) received nominations for essentially the same area from five separate companies.

the Mahogany Zone and in addition contain thick (300 to 400 feet) rich shale zones under the Mahogany Zone that contain some nahcolite and considerable quantities of dawsonite (300 to 500 feet thick on both tracts). Both of these tracts contain a relatively thick leached zone that is in the lower part of and below the Mahogany Zone. The leached zone contains moderately saline water. During the exploratory drilling phase, a greater amount of informational drilling was done on and adjacent to these tracts than any other nominated tracts.

Tracts C-4 (5, 7, 8, 17), C-10, and C-11 were considered as being of possible interest for surface mining. Considering only oil shale of 30 gallons per ton in thickness greater than 10 feet, the ratios of overburden plus waste rock to oil shale[1/] are: C-4 (5, 7, 8, 17) 1.7:1, C-10, 1.6:1, and C-11, 1.9:1. If 25 gallons per ton oil shale is mined and retorted, the waste rock plus overburden to oil shale ratio becomes C-4 (5, 7, 8, 17), 1:1, C-10, 1;3:1, and C-11, 1.2:1. However, from 900 to 1,100 feet of overburden would need to be removed before oil shale extraction could begin on Tract C-10 or C-11, thus limiting their consideration for economic attractiveness because of the long interval of time needed to reach the deposit. By contast, Tract C-4 (5, 7, 8, 17) contains less than 500 feet of overburden and would require less time to reach the deposit and therefore a faster economic return could be attained than at either of the other two

1/ As defined in footnote 1, table IX-4.

tracts. Additionally, this tract was the subject of 5 different nominations. Based on these factors, surface mine development was judged to be preferable at Tract C-4 (5, 7, 8, 17).

Tracts C-6, C-10, C-11, C-13, and C-16 were all judged capable of meeting the program objective of an underground mine development in an area likely to contain water. Although Tracts C-4 (5, 7, 8, 17) and C-1 could also be developed by underground methods, each contains limited reserves of the Mahogany Zone (50 feet or less) as compared to the other tracts considered in Colorado for underground development (from 70 to 150 feet). Thus, Tracts C-1 and C-4 were not given further consideration for underground development.

In summary, of the seven tracts in Category c, Tract C-4 (5, 7, 8, 17) was judged most suitable for development by a surface mine, and Tracts C-6, C-10, C-11, C-13, and C-16 as suitable for underground development. Tract C-1 was not considered further due to its limited potential for achieving the program objectives. The remaining tracts were examined for relative environmental impacts as discussed in subsection b. below.

(2) Utah.- Of the four tracts nominated in Utah, Tracts U-1, U-2, and U-4 (5) are quite similar and were rated higher than Tract U-3 on resource value and minability. Oil shale averaging 30 gallon per ton or more is approximately 50 feet

thick on Tracts U-1, U-2, and U-4 (5) and only 26 feet thick on Tract U-3. Depth of overburden on Tracts U-1, U-2, and U-4 varies from 700 to 850 feet while overburden on Tract U-4 ranges from 2,000-2,500 feet. None of the tracts nominated in Utah were considered attractive for surface mine development because of the high overburden to ore ratio, but could meet the objective of underground mine development in a low ground water content area or in situ processing. Tract U-3 was not considered further because of its lower resource value and greater depth of overburden.

(3) Wyoming.- Comparative evaluation of the Wyoming tracts was limited to the three tracts nominated in the Washakie Basin, which are contiguous and have similar characteristics. None of the tracts are rated desirable for development by mining and surface processing due to the low grade of the oil shale deposit. All are judged feasible for in situ processing. Tracts W-1 and W-3 are cut by small normal faults along their western side. Tract W-2 contains no known faults. All three have approximately the same resource value and all were considered further as discussed below.

b. <u>Environmental Considerations</u>

The comparative evaluation of the possible environmental impacts resulting from development of each tract (presented in Section G of this chapter) involved consideration of the following environmental values:

(1) Water Quality
(2) Air Quality
(3) Vegetation
(4) Fish and Wildlife
(5) Recreation
(6) Grazing
(7) Land and Cultural Features
(8) Archaeological and Historical Areas
(9) Socioeconomics

In general, the differences in impacts on socioeconomic resources, archaeological areas and cultural values are not sufficiently significant among the tracts to permit a meaningful comparison. The more significant variation between tracts in a given basin involved the potential impacts on water quality, air quality, commitment of land, vegetation, fish and wildlife, recreation, and grazing. These are discussed below for those tracts judged capable of meeting the program objectives as measured by the resource/development factors.

(1) Colorado; Underground Mine Development.- All of the nominated tracts considered most suitable for underground development in Colorado (C-6, C-10, C-11, C-13, and C-16) lie near the White River which might be affected by adverse impacts on water quality. The potential impacts for C-13 have been detailed in Chapter IV, Section C of this volume. Using this tract as a standard, development of Tract C-11 would be expected to produce a greater water quality impact since larger quantities of lower quality water (more saline) may need to be pumped and managed. Similarly, development of Tracts C-6 and C-10 might result in slightly greater impacts than

development of C-13 since C-6 is immediately adjacent to Piceance Creek and Yellow Creek flows through C-10 which increases the risk of materials entering surface waters. Development at C-16 could cause less water quality impact than development of Tract C-13 since the ground water is probably less saline. The quantities of ground water that may be encountered and the possible methods of management would be similar, however. In summary, considering proximity to surface waters and ground water quantity and quality, underground development of Tracts C-6, C-10, or C-11 would probably have greater impacts on water quality than would development of Tract C-13. Tract C-16 would probably cause less impact than C-13 but the difference in degree between the two is probably not great.

The total amount of air pollutants emitted from a 50,000-barrel-per-day plant would be the same regardless of plant location, but local topography may lead to differences in local ground level concentrations, especially under inversion conditions. Elevation and nearness to major valleys (which experience nighttime drainage winds) are factors which can account for differences in localized air quality effects. For example, higher elevation locations would allow introduction of emissions into larger atmospheric mixing zones which would generally tend to lower average ground level concentration of pollutants. The ranges of elevations for the five tracts under consideration are:

C-6	6,100 to 6,500 feet
C-11	6,200 to 6,700 feet
C-10	6,500 to 7,000 feet
C-16	6,500 to 7,000 feet
C-13	6,600 to 7,000 feet

Based on this, development at Tracts C-6 and C-11 would be expected to have a slightly greater potential for causing adverse air quality impacts than C-10, C-13, or C-16, which are about equal in this respect. Tracts C-6, C-11, and C-13 are near the Piceance Creek Valley and would offer somewhat more potential for local impact on air quality in the settled valley under local inversion conditions than would C-10 or C-16. Considering both elevation and nighttime drainage, development at Tracts C-6 and C-11 would probably have a greater potential for impacts on air quality than Tracts C-10, C-13, and C-16.

Since the area required for processed shale disposal, processing facilities, and related development requirements would be similar for each of the 5 tracts, land impacts would be expected to be generally similar.

Both existing plant cover and potential for revegetation are primarily dependent upon soil quality and precipitation. The tracts vary in the amount and quality of topsoil. Approximately 20 to 30 percent of Tracts C-6, C-13 and C-16 are covered with deep fertile soils whereas approximately 55 percent of Tract C-11 and nearly 65 percent of Tract C-10 have similarly good soils. In general, precipitation in this region increases

with elevation due to adiabatic influences. Thus, based on the elevation range of the 6 tracts previously listed, Tracts C-10, C-13, and C-16 would be expected to have somewhat higher precipitation possibilities than C-6 and C-11. The ridges and steeper slopes have shallow soils which support stands of pinyon-juniper with a sparse understory of perennial grasses and shrubs. Drainage bottoms generally have deep light colored saline soils which support dense stands of sagebrush, rabbitbrush, greasewood and other salt-tolerant species. Deep, dark colored soils are interspersed throughout the basin where exposure and slopes are favorable to development of deeper soils. The deeper soils support heavy stands of shrubs (such as sagebrush, serviceberry, mountain mahogany and bitterbrush) with an understory of perennial grasses. The initial vegetation loss due to development would be greatest on those tracts with a high proportion of deep fertile soils (C-10 and C-11). However, the potential for revegetation of these tracts should also be higher.

All 5 of the tracts in Colorado contain important wildlife resources indigenous to the pinyon-juniper vegetative type. Although a wide range of important wildlife resource values is involved, utilization of important winter range habitat in the Piceance Creek Basin by mule deer is a priority consideration.

Individual variations in species populations, distributions, and recreational use values between tracts are related to localized differences in the existing environment, and surface management objectives as discussed in Section G of this chapter. The potential impacts of oil shale development on fish, wildlife and recreational values are functions of actual low or degradation of habitat, interjection of external stress factors resulting in reduction of populations, disruption of normal behavior or distribution patterns, and loss of public use or access. Wildlife species on the tracts which would suffer the most significant impacts are mule deer, mountain lion, various raptor species (hawks, falcons, eagles), sage grouse and wild horses.

Development of Tracts C-6, C-10, and C-11 would be expected to produce greater impacts on fauna since they are more closely associated with important migration and winter movement routes or lie within the critical winter range elevation zone. All three tracts are also in the deer winter range area being managed largely for the benefit of wildlife species and recreational uses. Additionally, development of Tract C-10 would result in the penetration by industry into the more remote and primitive portions of the Piceance Creek Basin.

Tracts C-13 and C-16 are at the upper margin of the deer winter range zone, less critically situated with relation to

migration and seasonal movement routes, outside the area of intensive habitat management for wildlife, and less accessible to the public for recreational use due to restrictive actions by adjacent private landowners, than either Tracts C-10 or C-11. Tract C-13 is situated adjacent to Piceance Creek Highway and a relatively short distance from Colorado Highway 13. This location poses the fewest problems associated with industrial penetration of a remote area. Tracts C-11, C-13, and C-16 contain active golden eagle nesting sites which would be lost with development. Tracts C-13 and C-16 provide some winter elk havitat, and development of Tracts C-6, C-11, and C-13 would have the highest impacts on aquatic habitats due to their proximity to Piceance Creek and the White River drainage.

Overall, development would result in greater total impacts on fish and wildlife for Tracts C-6, C-10, and C-11 than for Tracts C-13 and C-16, and somewhat greater for C-16, as compared to C-13.

Since the amount of land required for development is similar, the impact on grazing would be approximately proportional to the current grazing use. As shown by the tabulation below, development of Tracts C-10 and C-13 would have a greater potential for impacts on grazing than C-6, C-11, and C-16.

Tract	Grazing Use, Animal Unit Months
C-13	650
C-10	600
C-6, C-11, C-16	500

In general, the 5 nominated tracts listed above are similar with respect to historical, archeological and cultural features. Tract C-16 is the closest in proximity to the location of the Atomic Energy Commission's May 1973 Rio Blanco experiment involving the use of nuclear devices to increase the flow of natural gas which underlies the oil shale in the Piceance Creek Basin. (For discussion, see Volume II, Chapter 5, Section B).

Based on the environmental impact descriptions and analyses contained in this volume and the foregoing comparative evaluation of possible environmental impacts, it is estimated that underground mine development of Tract C-13 would have the least overall environmental impacts as compared to similar developments at Tracts C-6, C-10, C-11, C-13, or C-16.

(2) Colorado; Surface Mine Development.- Tracts C-4 (5, 7, 8, 17), C-10, and C-11 were judged feasible for surface development as indicated in the resource development analysis above. Each is examined below for its relative environmental impacts.

Assuming full development of the underlying resource, land required for disposal at either Tracts C-10 or C-11

would be about two times that of C-4 (5, 7, 8, 17) due to the relative thickness of the overburden plus oil shale, that is, 1,670 feet for Tract C-10, 2,000 feet for Tract C-11 and 900 feet for Tract C-4 (5, 7, 8, 17). The location of the disposal areas may also differ. Development of Tract C-10, being adjacent to C-4 (5, 7, 8, 17) on its eastern boundary, may enable use of the disposal area described in Chapter IV, Section A, which is about 9 miles west of Tract C-10 outside the Piceance Creek Basin. Tract C-11, being closer to the center of the basin and at a much lower elevation, would probably not be able to utilize this disposal area and disposal would likely take place near the tract itself. Considering the amount of land required for disposal and tract location, the greatest impacts on land would probably arise from development on Tract C-11, somewhat less on C-10, and significantly less on C-4 (5, 7, 8, 17).

The potential impacts on water resulting from development of Tract C-4 (5, 7, 8, 17) have been described in Chapter IV, Section C. By comparison, development of Tracts C-10 and C-11 would be expected to produce greater impacts. Greater thicknesses of overburden plus oil shale would need to be removed, which would require a longer pit sidewall. Therefore, a greater area would be exposed and larger quantities of water would need to be pumped to keep the pit floor dry. The resulting cone of depression surrounding

C-10 and C-11 would be larger in radius than that estimated for C-4 (5, 7, 8, 17), causing proportionally greater adverse impact on surrounding springs and wells and secondary effects on fauna and vegetation. In addition, this ground water would likely be of lower quality due to the location of Tracts C-10 and C-11 closer to the center of the basin. Yellow Creek which now flows north of Tract C-10 would cease to exist in the vicinity of the tract.

The elevations of the three tracts under consideration are listed below:

C-11	; 6,200 to 6,700 feet
C-10	; 6,500 to 7,000 feet
C-4 (5, 7, 8, 17)	; 6,700 to 7,300 feet

Based on these data and the location of Tract C-11 near the Piceance Creek Valley, which experiences nighttime drainage winds, development of Tract C-11 would be expected to have a somewhat greater potential for potential for adverse effects on local air quality than development of either Tract C-4 (5, 7, 8, 17) or C-10, the impacts of which would be similar to those described in Chapter IV, Section B.

About 55 percent of Tracts C-4 (5, 7, 8, 17) and C-11 contain deep fertile soils as compared to nearly 65 percent on Tract C-10. Considering the soils, precipitation (which increases with elevation), and particularly the amount of land required and the probable location of the disposal sites, the greatest impact on vegetation would be caused by development

of Tract C-11, while development of Tract C-10 would cause somewhat less impact on vegetation and C-4 (5, 7, 8, 17) the least.

On a comparison basis, development of Tract C-4 (5, 7, 8, 17) would result in the greatest penetration by industry into a relatively remote and primitive area and would have somewhat greater influence on seasonal movement patterns of migratory deer herds as well as the recurring use by wild horses. However, less total deer forage would be destroyed by development at Tract C-4 (5,7, 8, 17) than development at Tract C-10 or C-11 due to lesser land requirements for disposal. Also, Tract C-4 (5, 7, 8, 17) lies within the upper limit of the key winter range area. The elevational factor when considered together with more favorable soil and precipitation factors, would tend to make Tracts C-4 (5, 7, 8 17) and C-10 more amenable to subsequent revegetation and restoration than Tract C-11. Thus, considering the probable location of the disposal sites, revegetation destroyed and the water pumping requirements, and their subsequent impacts on fauna, the greatest impacts on fish and wildlife would be caused by surface development of Tract C-11. Such impacts would be significantly less with development of Tract C-4 (5, 7, 8, 17) or C-10.

Tract C-11 currently supports about 500 animal unit months of grazing, while C-4 (5, 7, 8, 17) and C-10 support about 600.

Due to greater land required for development at Tracts C-10 and C-11, the impact on grazing would be greater than that at C-4 (5, 7, 8, 17).

Thus, based on the environmental impact descriptions and analyses contained in this volume and the foregoing comparative evaluation of possible environmental impacts, it is estimated the surface mine development of Tract C-4 (5, 7, 8, 17) would cause less total adverse environmental impacts than development of either Tract C-10 or C-11.

(3) Utah.- As discussed previously, of the 4 tracts nominated in Utah, Tracts U-1, U-2, and U-4 (5) are suitable for underground mine development in a low ground water content area. In general, the adverse impacts on air quality, vegetation, grazing, archaeological and historical areas, and socioeconomics which would result from development of any of these 3 tracts are not sufficiently different to permit meaningful comparisons.

Tract U-4 (5) is the most easily accessible of the 3, thus requiring less land for access roads and utility corridors. Since Tract U-2 is contiguous with Tract U-4 (5), land requirements for access roads and utility corridors should be less for development of Tracts U-2 and U-4 (5) than for Tracts U-1 and U-4 (5).

Tracts U-1 and U-4 (5) are less favorable than Tract U-2 from the standpoint of potential adverse effects on the White River. This is due to presence of the Asphalt Wash drainage

for approximately 2 miles on Tract U-4 (5), both of which provide greater drainage exposure and more direct channels to the White River than does Tract U-2. Thus, even though the White River does transect the northern edge of Tract U-2, if these streams receive any accidental spillage of wastes or releases of low quality process water, or sediments eroded and salts leached from spent shale piles during the occasional flash floods known to occur in the area, these materials would have a more direct opportunity to reach the White River from development of U-1 or U-4 (5) than would such effects of similar incidents occurring on U-2. Due to the greater drainage area exposed, development at Tract U-1 offers a greater potential for adverse water quality effects than U-4 (5) which, in turn, offers somewhat greater potential problems than does development at U-2.

All 3 tracts contain important wildlife and recreational values, including valuable habitat and nesting sites for prairie falcon and golden eagle. The primary wildlife resources are generally the same. There are slight variations in recreational use due to the proximity of Tracts U-2 and U-4 (5) to the White River. Development of any of these tracts would be a penetration by industry into relatively remote areas. Tract U-1 is farthest from any improved road system and would exhibit the greatest penetration. Tract U-2 is closer to a county maintained highway system than Tract U-1 and the

penetration would be somewhat less. Tract U-4 (5) is bisected by a county highway and penetration would be less than for either of the other tracts.

Based on the environmental impact descriptions and analyses contained in this volume and the foregoing comparative evaluation, it is estimated that underground development of Tract U-2 or U-4 (5) would cause less total adverse environmental impacts than would development of Tract U-1.

(4) Wyoming.- As discussed previously, all 3 tracts nominated in Wyoming are feasible for development by in situ processing. Tracts W-1, W-2, and W-3 are contiguous to one another in a north-south direction, and are situated in a remote and relatively undisturbed range area. Development on any of these tracts would cause similar impacts on air quality, vegetation, fish and wildlife, recreation, grazing, archaeological and historical areas, and socioeconomics.

Due to common boundaries between Tracts W-1 and W-3 and Tracts W-1 and W-2, a choice of either of these pairs is considered logical to reduce the land areas needed for access roads and utility corridors. An unimproved road transects Tracts W-1 and W-3. Thus, these two tracts would require somewhat less commitment of land areas for access than Tracts W-1 and W-2.

Tracts W-1 and W-3 are known to have geologic faults on their western edge (See Table IX- 4). Since in situ processing

may lead to some ground water contamination, development of either Tract W-1 or W-3 could have greater impacts on ground water quality (because these faults may act as natural pathways for ground water movement) than development of Tract W-2.

Environmental considerations offer little basis for distinction in evaluating the relative environmental impacts of the 3 contiguous tracts in Wyoming. It is estimated, however, that in situ development at Tracts W-1 and W-2 would probably have a lesser overall effect on the environment than would in situ development of either W-1 and W-3 or W-2 and W-3.

c. Conclusion

Based on the previously discussed two-step screening procedure involving comparative evaluation of the nominated tracts in light of the interrelated resource development potential and environmental factors, it was estimated that leasing of Tracts C-4 (5, 7, 8, 17), C-13, U-2, U-4 (5), W-1, and W-2 (subsequently renamed C-a, C-b, U-a, W-a, and W-b, respectively) would collectively achieve the objectives of the proposal.

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